CR 144860

ANNUAL REPORT

JULY 72 - JUNE 73

A STUDY OF A DIVERSE COASTAL ECOSYSTEM ON THE ATLANTIC COAST OF FLORIDA

N77-80297
Unclas
00/48 36532

NASA RESEARCH GRANT NO. NGR 10-019-004

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Prepared by

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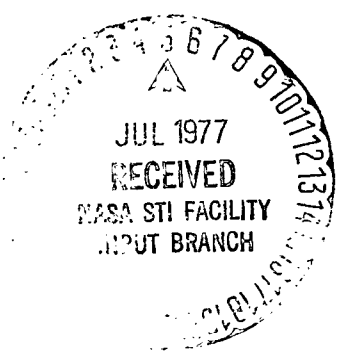
November 1973

(NASA-CR-144860) A STUDY OF A DIVERSE COASTAL ECOSYSTEM ON THE ATLANTIC COAST OF FLORIDA Annual Report, Jul. 1972 - Jun. 1973 (Florida Technological Univ.) 126 p



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JOHN F. KENNEDY SPACE CENTER, NASA

KENNEDY SPACE CENTER, FLORIDA

MASTER PLAN

DATE MAY 1971
SCALE GRAPHIC
TAB NO IV-1
SHEET NO

SCALE IN FEET

RUNWAY:
15,000' x 300'
W/50' HARD
SHOULDERS,
1000' OVER RUNS @
EACH END

NASA/KSC FEB/74

INTRODUCTION

This progress report is a brief summary of the work accomplished on this grant through July 1973. We have made no attempt to be detailed or all inclusive in the presentation and analysis of data. Since our studies are designed to cover a four year period, data reduction and analysis would be inappropriate at this time. This report attempts to present a broad overview of the types of work being conducted and the types of data being gathered. Some tentative observations and correlations are advanced and plans for future investigation are noted.

The overall objectives of this study are two fold: (1) to survey the biota and ecology of north Merritt Island and (2) to provide meaningful experience to undergraduate and graduate students who desire to pursue careers in bio-environmental science, conservation, and pollution control.

In accordance with the first objective, we have established three major study programs: (1) description and quantification of plant communities; (2) population dynamics in mammals; and (3) ecology of fishes. These three study programs correspond closely with the training and expertise of the three principal investigators. We have, in addition, made substantial efforts to gain a qualitative understanding of the other vertebrate groups inhabiting the island (amphibians, reptiles, and birds) but our studies in these areas have necessarily been more limited. Although the study programs are treated herein as separate disciplines corresponding to the organisms involved, in reality our approach is integrated and our ultimate objective is the understanding of the interactions of communities.

Although this study applies to the 40,000 acres or 62 square miles of northern Merritt Island (north of Banana Creek), the major study efforts to date have been concentrated in an area of about 16 square miles in the south central portion of the Island. This priority was influenced by the impending

construction of the landing facility for the space shuttle program. For purposes of intensive study, we have established permanent study sites in representative plant and aquatic communities. The location of these study sites is noted on the map (Figure 1).

In accordance with our second overall objective, we have made active efforts to recruit and involve students in all phases of this study. To date, six graduate (master) students and twelve undergraduate students have participated and this program has become a valuable part of the education of many other students at Florida Technological University. Four of our graduate students have selected thesis research problems involving research on Merritt Island and several other students are considering doing likewise. In addition, four undergraduate students have submitted research reports dealing with studies conducted, through the auspices of this grant, on Merritt Island; several similar projects are underway. Upper level Zoology courses taught at FTU have used Merritt Island as a living laboratory, providing students with practical experience in field research.

Our success in stimulating students is testified to by the fact that three of our undergraduate participants have progressed on to graduate-level study in biology. Judging from the general reaction of students concerning this grant, we anticipate no problems finding willing and qualified students to train.

One "spin-off" benefit from this research program is the establishment of a museum collection of biological materials that will be available for the studies of qualified biologists throughout the world. Merritt Island has many interesting and unique elements in its biota and we are taking great care to properly preserve, identify, record, and maintain representative samples for future documentation and use. These archives, along with published research reports, will constitute the most meaningful and lasting scientific contributions of this grant.

BOTANICAL STUDIES

Introduction. Merritt Islands' natural state has been affected by man in numerous ways prior to NASA's purchase of the island. Persons living on the island were fairly scattered, although the roads for housing developments were initiated in at least two areas. Orange groves and cleared pasture land were also scattered; such cleared areas are readily recognizable and constitute only a small percentage of the island. A practice more widespread but of little or no long term impact was the grazing of cattle on the numerous Spartina marshes. Most of the islands coastal marshlands have been altered by the construction of two sets of dikes, impounding water within them. Each impounded area is different and the alteration of the plant communities ranges from almost no change to a complete destruction of the area. In the past, periodic fires were a frequent and common occurance on the island. Recently, the island has been protected from fire by efficient fire protection measures, thus favoring the growth of fire intolerant species. In spite of all of these influences, the vast majority of the island has not been disturbed by human influence, has numerous naturally occuring plant communities, and represents one of the few unspoiled coastal areas in Florida.

Classification of Plant Communities. The first task of the botanical studies was to determine which of the numerous plant associations are true plant communities: i.e. plant associations which represent a distinct, stable, homogenious group of plant species rather than a minor shift in the species composition due to a slight

transition in the environment. Due to the absence of detailed ecological studies in the eastern central Florida area, many designations developed by Florida ecologists are not directly applicable to Merritt Island. Thus, it has been necessary to both create several new designations of plant communities as well as to modify some of the existing communities descriptions. Of thirty plant communities described on the northern end of Merritt Island, 25 are naturally occurring associations (not resulting from man's activities). For convenience, these communities are broadly classified according to the height of the vegetation: i.e., whether the conspicuous feature of the community is grasses, flatwood or trees. These classifications were then subdivided according to the moisture content as well as by the presence or absence of salt in the environment. A complete listing of the communities identified to date as well as a listing of the conspicuous plant species which are commonly found in each association is given in Table 1.

Once major community types were ascertained, then permanant 7 acre study grids were established in some of the more ecologically typical areas. (See figure 1 for geographical location) These areas have been intensively studied to determine both the faunal and floral componants of the community. Definition of the botanical aspects of these areas was accomplished using the vegetational analysis methods of Daubenmire (Northwest Science 33:1, 43-64, 1959) on randomly selected sites within the study area. In this manner, each major community was qualitatively described by naming each plant species encountered, and quantitated by determining both the coverage or influence exerted by each species on the area and the species' relative abundance. The data in Tables 2-6 lists the plant species present in each community investigated to date as well as that species

percent coverage and percent frequency.

Of the 30 plant communities described, they can be consolidated into 6 major classes of associations:

1. Flatwoods. This is an association dominated by shrubby vegetation, in which all plants except occasional trees are about the same height within a 2 to 10 foot range. The flatwood communities have evolved in the presence of periodic low temperature fires and can be termed a fire climax community. Thus, the association depends on fire to destroy competing bushes, to remove litter and to return nutrients to the soil: when deprived of fire, many species typical of flatwoods disappear and are replaced by fire sensitive species. In general, the flatwoods are dominated by saw palmetto (Serenoa repens), Lyonia Spp., oaks (Quercus Spp.), dwarf wax myrtle (Myrica pusilla), huckleberry (Gaylussacia Spp), blueberry (Vaccinium Spp), and wire grass (Aristida Spp). Table 2 presents a complete listing of flatwood species with quantitation of the degree of dominance for each species.

Scattered throughout the flatwoods are extensive marshy areas called grass swales. These swales are typically composed of various grass species (Andropogon, Spartina, Aristida), red root (Lachnanthes carolinana), sundews (Drosera Spp.), Sphagnum, and herbs. The domination of grasses, the rapid transition from flatwoods to emergent aquatic vegetation, the small size, and the differing species composition depending on location, make this community type very difficult to quantitate. In addition, since the central areas of the swales are subject to both flooding and drying, the faunal componants of the swales changes with the seasons. Due to their

ephemoral nature, they have been sampled for fish but not used as a permanant study grid.

The flatwoods can be further subdivided into the pine flatwoods and the scrub flatwoods. The major flatwood type on Merritt Island is the pine flatwood which is found on Leon fine sands, a poorly drained, low runoff, very acid soil. The vegetation differs from the scrub because slash pine (Pinus elliottii) may be present as a dominant (south of Banana Creek) or very sparsely scattered (north of the creek): Lyonia lucida, Quercus pumilla and Aristida are always dominant (table 2). Scrubby flatwoods are found on the high areas of the island growing in St. Lucie fine sand, an excessively well drained, acid soil. Species characteristic of the scrub include Quercus Myrtifolia, Q. chapmanii, Lyonia ferruginea and widely scattered sand pine (Pinus clausa) (Table 2). Other variations of the flatwoods observed are: Coastal flatwoods which are dominated by palmetto, live oak (Q. virginiana) wax myrtle (M. cerifera) and and Eugenia. (Table 2) This phase is apparently enriched by nutrients provided by the salt spray and is a much taller flatwood. Salt margin flatwoods are dominated by palmetto, groundsel (Baccharis glomeruliflora), Juniper (Juniperus silicicola), wax myrtle and Spartina. The apparent influence of saline soils on the pine flatwood apparently results in the additional presence of salt tolerant species. The coastal strand is a thin flatwood community beginning at the edge of the beach and extending through the first series of dunes. The dominant species include saw palmetto, buckthorn (Bumelia), seagrape (Coccoloba uvifera), spanish bayonet (Yucca alvifera) and Sea Oats (Uniola paniculata) (Table 2).

Although the flatwoods are extremely stable in the presence of fire, it appears that they are very easily disrupted by mechanical purtibation and changes in moisture. The single path of a vehicle made over a year previously, paths not used for over 10 years, and partially cleared areas deserted for perhaps 20 to 30 years have showed no signs of returning to their original state.

2. Hammocks. Although all dominated by trees, these areas may differ vastly in their species composition. In general, the wooded areas are restricted to areas which are occasionally flooded during the year and composed of soils very high in organic material with poor drainage.

Due to the high soil moisture levels, these areas are resistant to fire and accumulated debree is removed by surface fires with little damage to the trees. Trees such as palm (Sabal palmetto) or persimmon (Diospyros virginiana) are more fire resistant and are usually selected by repeated burns to be thickest at the edge of the hammocks. These trees apparently allow the soil to retain moisture so that even a rapidly advancing grass fire will be reduced in intensity. Removal of these trees allows drying of the area and permits subsequent devestation by fire. Any significant changes in the soil moisture level by activities such as draining or opening of the canopy (which speeds the loss of soil moisture) will increase the probability of a damaging fire.

In addition to the effects of fire, hammocks can be greatly altered in species composition by changing the water level or the drainage flow. Furthermore, any opening made in the canopy will admit wind and during a hurricane, allowing it to have devestating effects on the trees. Although these hammocks represent a climax

stage, the restoration of such an association to its natural state may take a century; in addition, severe perturbation may permanently eliminate several species from the area.

There have been several major types of hammocks observed on north Merritt Island, each of which reoccurs in several widely spread locations. The two most frequently occuring types are: a. Hardwood hammock. This type of hammock is most common in the area between Peacocks Pocket Road and Happy Hammock Road and contain live oak, cabbage palm, palmetto, marlberry (Ardisia escallonioides), lancewood (Nectandria coriacea), Myrsine guianensis, bay (Persea Spp), mulberry (Morus rubra), wild coffee (Psychotria) and huckelberry (Celtis laevigata). In very wet areas, elm (Ulmus floridana), holly (Ilex cassine), red maple (Acer rubrum) and Laurel oak (Q. laurifolia) may also be found. (See table 11 for a partial listing). This hammock type is considered to be a climax form and will remain in this stage indefinately unless there are environmental changes. b. Palm hammock. These stands most frequently occur west of Peacock Pockets Road where areas are flooded most of the year. This hammock is comprised of almost nothing other than cabbage palm trees with an occasional fern or bunch of grass. The light intensity is so reduced that little else is able to compete. This community type is considered to be stable.

Also occuring on the island but of minor importance are: C. Willow Stands: Willow(Salix carolinana), constitutes an early successional stage and is often the first tree to move into ditches and deserted wet meadows. In addition, if a spartina marsh is prevented from burning, Willow will move in and eventually dominate the area.

It is possible that the willow is later replaced by a palm or hardwood hammock. d. Sweetgum stands. Sweetgum (Liquidambar styraciflus) is a tree completely missing from the island except in two locations where it is the only tree present. e. Red maple stand. In one location, red maple is the only tree present in an extensive stand.

3. Palm-Oak-Wax Myrtle communities. This association is considered to be the transition from flatwoods to hammock; as such it is extremely variable in hight and species composition. This association, like the flatwoods, has grass swales or spartina marshes dispersed throughout it. This community is found on moist, poorly drained soils and is apparently fairly fire resistant due to the water in these areas.

The dominant species found are live oak, saw palmetto, cabbage palm, wax myrtle, groundsel, ferns, grape (Vitis rotundifolia), persimmon, Smilax Spp. and various herbacious species (Table 3). The ratios of these various elements is very variable depending on the particular transition stage and the time since the last fire.

4. Palm Savanna. This community type could be considered as a transition zone between both the palm-oak-wax myrtle community or the palm hammock and the spartina marsh. This community is usually found in flood plains and on the edge of marshes where the ground may be lightly flooded for most of the year. This association is also considered to be a fire climax community due to the great resistance of the palms to, and the dependance of spartina on, fire. Although major increases in water level is fatal to this association, areas within some impoundments appear unchanged after being continuously

flooded with perhaps as much as 1 foot more water than normal for 10 years. Other impoundments have been drained after the extensive flooding and appear to still be viable. However, in all probability, species more able to tolerate dry areas will eventually dominate.

Species found in the savanna include bunch grass (Spartina bakerii), black rush (Juncus roemerianus), Sagittaria latifolia, cabbage palm, leather fern (Acrostichum danaeaefoliam), and Sea oxeye (Borrichia frutescens) (Table 4).

5. Prairies and Marshes. These communities are scattered throughout much of the hammock and palm-oak-wax myrtle communities and also surrounding the fringes of the island. Most of these communities are now impounded since the inner dike system was positioned using the change in vegetation type as a guide. These marshes are partially flooded for most of the year although there is some evidence that even the deepest portions have dried for a period of time. The soil is often just a few inches of organic muck on a coquina base.

One major community type is the spartina marsh. Although the marsh appears to be fairly homogenious, once the investigations began, it was clearly divisable into four distinct phases. After the entire marsh had been mapped showing which vegetation phase was present at each of the 144 trapping stations, this information was consolidated with the water depth at each station averaged over three seasons. Figure 2 shows that the particular phase of the vegetation is correlated with the mean water depth with the shallow phase limited to 0 to 5," the intermediate phase found at 4 to 10" and both the deep spartina and saw grass overlapping in similar depths of 8 to 20 inches. Although the exact

species composition varies with depth, the most common species found were Spartina, Saw grass (Cladium jamaicensis), salt grass (Distichilis spicata), cut tail (Typha latifolia), Ludwegia, black rush, heartweed (Polygonium persicania), hempweed (Mikania scanderns), red maple, willow, persimmon, leather fern and groundsel. (Table 5)

In addition to having fairly extensive stands of Spartina, the prairies may be dominated by fairly pure stands of saw grass, cat tails or a mixture of Distichilis spicata and Paspalum. In each case, the dominant plant will be growing to the exclusion of the others. Saw grass stands are abundant but are very susceptable to the effects of man. If disrupted by building or if the water level is lowered and a fire begins, the saw grass will not regenerate, being replaced by Spartina. The cat tails are rapidly advancing into any recently opened water and the increase in these stands in the last 5 years is enormous. Cat tails are propigating in the deeply flooded regions around the edge of the impoundments. Since they flourish in water too deep for Spartina but within the acceptable range of saw grass, these stands may be eventually replaced by sawgrass. More shallow, saline areas are often covered with floating stands of Distichilis. These plants seem to tolerate fairly wide fluctuations in water level and may even withstand short periods of drying. Areas which are subject to periodic flooding and drying are most frequently covered with fairly pure stands of Spartina grass. These stands are a fire climax, depending on burning to remove maple and willow as they begin to become established.

6. Mangrove stands. This community type is found all around the fringe of the island, in some impoundments and in some areas near Mosquito Lagoon. These plants are very succeptable to damage, being

easily killed by frost. In addition, an increase in water level of about a foot will kill the pneumatophores within about 1 week. Furthermore, any operations such as dredging or hurricane-caused flooding which covers an area with silt will kill the trees by covering the pneumatophores.

These communities are found in lightly flooded areas of high salinity. The major species are white mangrove (Laguncularia racemosa), black mangrove (Avicennia geminans), Spartina alternafolia, leather fern, Batis, Saliconnia, Spartina bakerii, groundsil, and juniper.

7. Ruderal areas. These disturbed areas are too numerous to attempt description. A list of the types of disturbances include: Orange groves, australian pines (Table 6), exotic plantings near foundations, eucalyptis, road sides, deserted yards and dikes.

The diversity index of each community type which had been quantitated was determined using the Brillouin index according to Lloyd, Zar and Karr (American Midland Naturalist, 79,(2) 257-272, 1968). A comparison of these values is presented in Table 7, allowing an estimation of the complexity of each community.

Mapping Plant Communities. Once the types of plant communities were defined and described, the boundaries and the surface area covered was mapped for each community located in an area roughly bounded by the Indian river on the west, Rt. 402 on the north, Banana Creek on the south and Happy Creek Road on the east. Delineation of the boundaries was prepared from a photographic mosaic on a scale of 1/10,000 (1 inch = 833 feet). The accuracy of community identification was facilitated by the use of a 1/4874 scale (1" = 406') photographic survey prepared in December 1969, a two hour flight over the area, extensive low altitude color photographs, a

1" = 1000' photographic survey prepared in February 1973, and approximately 400 man hours of field confirmation. The map showing the vegetation in an area approximately 16 square miles, including the area immediately impacted by the runway, has been included in this report (Figure 3): Figure 4 shows the same area with an overlay representing approximately the area directly impacted by the shuttle runway. The map covering the western end of the island has not been included in this report. Using Figure 3, the relative coverage of each community has been estimated; as can be seen in Table 9, the flatwoods constitute about 49% of the area depicted in Figure 3 while hammocks constitute about 5%, palm-oak-wax myrtle covers 16%, savanna equals 5%, prairies and marshes are 16% and mangrove covers 2%.

Floral Reference Collection. During the course of community description and mapping operations, collections of all flora not previously observed were made. These specimens were pressed, dried, permanently mounted and stored in a reference herbarium containing all the species collected from the Island. As can be seen in Table 9, as of July 12, 1973, over 537 separate plant species have been either collected and included in this collection or observed on the island. It is anticipated that this collection, when complete, will house over 650 species obtained strictly from the north end of Merritt Island.

One important finding resulting from preparation of the reference collection is that there are many species of plants which are conspicuously absent from or present in reduced numbers in the area. (Table 10). Many of the environments on the island appear identical to areas located elsewhere in eastern central Florida except that some plant species normally expected in the environment are missing. Although one would suspect that the area may be influenced by an

environmental stress which is detrimental to the growth of these plants, we have found a few representatives of many of these species which are growing and appear to be healthy; this indicates that the absence of these species may be caused by other factors such as seed dispersion and survival.

During the course of the botanical investigations, many observations were made which indicate that there have been dynamic changes in the plant composition of areas due to environmental changes. Although the species shift occuring in impounded areas is understandable and predictable, other changes are more subtle and perplexing. In an attempt to quantify the change of one such area, the reproductive status of a hammock was determined (Table 11): the results indicate that the hammock is transforming from mesic to hydric. It appears that for some unknown reason, the area has become much wetter during the last 50 years.

Future Work. Although we have successfully described the types of plant communities and determined the relative portions covered by each on the southern end of north Merritt Island, there is still a considerable amount of botanical research that must be performed. For example, there are probably in excess of 100 species of plants that have yet to be collected on the island. Also, the detailed description of all the species normally occurring in each plant community needs to be completed. Furthermore, there are several questions raised by the research to date that are worthy of considerable research. The unusual absence of certain plant species needs to be pursued and thoroughly examined. In addition, we must determine how the plant communities are changing and then relate these responses to the casual natural environmental alterations. In addition, detailed studies on

the ecology of one of the most dominant species on the island, saw palmetto, will begin as time allows. These and many more enigmas concerning the ecology of Merritt Island need further study.

MAMMAL STUDIES

Introduction. The fauna of Merritt Island is diverse and varies considerably from community to community. It is not possible, of course, to study all of the faunal elements and so there are many which we have had to ignore, others that have been lightly treated and still others that have been studied intensively. One group to which considerable time and effort have been devoted is the Mammalia. The primary goal has been to develop a quantitative understanding of the population dynamics of several of the more important mammals of Merritt Island. From the outset there has been a continuous effort to correlate the mammal studies with the botanical work, and the mammals have been treated primarily as components of communities that are defined mainly by the plant associations that characterize them.

Methods. Small mammal populations are being studied primarily on three gridded study areas, each study area being representative of a major Merritt Island community type. The first is in the flatwoods (with some shallow, fresh-water marsh) at Sec. 27, R36E, T21S; the second is in mixed scrub at Sec. 36, R36E, T21S; and the third is in a fresh-water Spartina marsh at Sec. 21, R36E, T21S. Each of these study areas consists of 12 rows and 12 columns (perpendicular to the rows) at 15 meter intervals. There is a trapping station at each intersection of grid lines so that each area has 144 stations on 27,225 m^2 (slightly less than 7 acres). Two Sherman small mammal live traps are set at each station on sampling days. Each area is trapped for one 6-day period per season. Traps are baited with a combination of peanut butter and oat flakes before the first day and freshened with oat flakes

before the third and fifth days. During the first few months of the study all captured animals were handled and all data were recorded in the field. More recently we have found that it is convenient to take captured animals (in the traps) to our field laboratory for processing and then return them to the study area for release at the capture station within 2 or 3 hours. Handling the animals in the lab is preferred because of the variety of equipment (e.g., electronic balance) and supplies available there and the fact that the controlled climate allows unhurried examination and promotes neat, efficient recording of data. On any given date the following data are recorded for each captured small mammal: number, species, station, sex, age, reproductive condition, ectoparasites present, molt, and miscellaneous notes. Each small mammal is numbered by toe clipping according to an established scheme. Occasionally animals weakened by exposure are held in the laboratory overnight, given food and water, and then released the following day. Table 12 summarizes our trapping effort from the summer of 1972 through the spring of 1973. The general scope of the small mammal studies is indicated by the fact that we accumulated well in excess of 20,000 trap nights during the first year.

The larger mammals, such as raccoons, opossums, and spotted skunks, are generally more mobile and nomadic so that considerably more effort is required to obtain meaningful data concerning their numbers and habits. From June through February our procedures included: (1) setting one large trap (10" x 12" x 32") at each of 15 randomly selected stations on the small mammal study areas for the usual 6-day period; (2) setting out lines of 10 traps at 75 m intervals for four days on many parts of Merritt Island. In March we began an intensive program of large mammal trapping on the coastal strand between the Atlantic Ocean and Mosquito Lagoon from

Playalinda Beach to Klondike Beach. It began as a cooperative effort with the Fish and Wildlife Service (U.S.B.S.F.W.), which supplied additional men and vehicles. In the beginning we trapped 10 miles of the barrier strand, primarily in an effort to gain an understanding of populations of those predators which destroy marine turtle egg nests on the beach. It has become clear to us that, even though the FWS is no longer able to help, the coastal strand affords an opportunity to study the population ecology of these larger, primarily carnivorous and omnivorous mammals that is unmatched by any other area on the refuge. This is true for reasons of geography (the nagging problems of emigration and immigration are essentially eliminated by the fact that Mosquito Lagoon isolates this land mass from the remainder of Merritt Island except for narrow connections at the north and south); security (stolen traps are a constant problem on many unsecured parts of the refuge), and access (an improved road bisects the southern 5 miles of the strand). For these reasons we have begun to consider the more southerly 5 miles of the coastal strand (ca. 212 hectares) as a large "study area" and have continued to work there when time permits. On the coastal strand our procedure has been to establish 100 trapping stations at .05 mile (ca. 80 m) intervals along the road and to set two large mammal live traps at each of these. The two traps are set on opposite sides of the road at an average distance of 25 m from the mid-line and are baited daily with fish-flavored cat food. All of these larger mammals are processed in the field. All are weighed on a dial spring scale suspended from a boom mounted in the bed of a pick-up truck. The same data as mentioned above are taken but an additional measurement, hind foot length, is also recorded and the animals are numbered by attaching a monel metal tag

to the external ear. All animals are handled in a large denim bag but differences in size and temperament dictate some variation in the remainder of the handling procedure. Raccoons are anesthetized; skunks are separated from the handler by a shroud; and opossums, rabbits, and armadillos are handled without special precautions.

There have been some limited attempts to deal with even larger predaceous animals such as bobcats and they have met with equally limited success. Large, custom-made traps baited with live fowl are used.

Large mammal traps are also used on a 10 x 10, 100-trap gridded study area in a salt hay marsh near Mosquito Lagoon (Sec. 24, R36E, T21S). It was established especially for the study of the large population of Neofiber alleni (round-tailed muskrats) that occurs there. Priorities have been such that little work has been done in this area but we did accumulate 1000 trap nights in late September - early October, 1972. These trap nights are included in the "island interior" category of Table 12 which also summarizes all of the trapping involving the larger traps, both in the island interior and on the coastal strand.

Small Mammal Population Patterns

Population Densities

The questions we are seeking to answer here are: (1) What are the population densities of the various small mammal species under normal conditions?

(2) Do they fluctuate from season to season? And, if so, what is the normal pattern of these fluctuations?

(3) Do these densities vary from community to community? If so, what trends are apparent in this variation?

The graphs in Figures 5 , 6 , and 7 summarize the answers to these questions for the summer, 1972 to spring, 1973 period.

In the flatwoods, cotton rat (Sigmodon hispidus) populations were quite high (18.3/hec.) in July and August, 1972. Comparisons with subsequent work here and elsewhere indicate that our work began at a time when Sigmodon numbers were at a peak, or, perhaps, were already decreasing from some even greater density. The flatwoods Sigmodon population was characterized by a mean weight of 118.1 grams, a sex ratio of 14 males to 18 females, and an age structure that included no juveniles (weight less than 50 gr.).

By November, flatwoods Sigmodon population densities had fallen off considerably to a level of 7.9/hec. Some breeding had occurred, however, during this part of the decline because 3 of 16 animals were juveniles and the mean weight was down to 100.2 gr. Interestingly, the sex ratio (14 females: 2 males) markedly favored females. It is doubtful, however, that this is a true reflection of the sex ratio of the population at large; rather, it probably indicates a behavioral disinclination to enter traps on the part of males.

Sigmodon populations continued to decline through the winter (4.0/hec.) and spring (2.0/hec.) seasons. The total number of animals involved during these periods was so low that age structures and sex ratios are meaningless, but during both seasons the mean weight was just slightly over 81 grams. Also, the presence of one juvenile in early June indicates that at least some breeding was occurring even though densities continued to drop.

The only other small mammal of any consequence in the flatwoods is the cotton mouse, Peromyscus gossypinus, and its numbers are apparently never very great there (Fig. 5). Densities ranged from 1.0/hec. in the summer to 4.9/hec. in the fall, 2.5/hec. in the winter, and 1.5/hec. in the spring. The total numbers involved are too low for any meaningful accounting, but the mean weight ranged from 28.7 gr. in the summer to 23.5 gr. in the winter.

Fig. 5 also summarizes population trends of the rice rat Oryzomys palustris. This species did not occur in the flatwoods proper but in a section of shallow, fresh-water marsh that protrudes into the flatwoods study area. The marsh comprises 0.56 hectares and it is on this area that Oryzomys density figures are based. Oryzomys captures were almost entirely restricted to the marsh but occasionally one was taken in the dense margin of palmettos that surrounds the marsh. Contrastingly, Sigmodon was almost never taken in the marsh, even during dry periods when there was little or no standing water there.

The golden mouse (Ochrotomys nuttalli) and the least shrew (Cryptotis parva) also occur in the flatwoods, but in numbers insufficient for analysis.

In the mixed scrub habitat Sigmodon densities were also extremely high in the summer (31.6/hec.), paralleling but exceeding those in the flatwoods (Fig. 6). The mean weight of the population was 134.0 gr.,

the sex ratio favored males 1.5:1, and only 2 of 73 animals were juveniles. As in the flatwoods, cotton rat populations fell off precipitously as the year progressed. In the fall density dropped to 6.6/hec., in the winter it was 1.9/hec., and in the spring, 1.2/hec. The average weight dropped to 106.8 gr. in the fall, the sex ratio was near unity (9 m: 8 f), and 2 of 17 individuals were juveniles. Total numbers of cotton rats caught in the winter and spring were very low and make further analysis useless.

P. gossypinus also occurs in the scrub but density patterns appear to be nearly opposite those of Sigmodon. P. gossypinus densities ranged from 0.8/hec. in the summer to 6.6/hec. in the fall, 7.4/hec. in the winter, and 3.9/hec. in the spring. Mean weights were 19.5 gr. and 24.2 gr. in the fall and winter, respectively, sex ratios varied somewhat (fall - 8 m : 9 f; winter - 6 m: 13 f), and 4 of 17 fall animals were juveniles while all winter animals were adults. In the spring the sex ratio of 10 adults favored males three to two, the mean weight of the population was up to 28.1, and there were no juveniles caught.

One of the most interesting ecological relationships among small mammals in peninsular Florida is that between P. gossypinus and another scrub dweller, P. floridanus. Two supposedly closely related animals with supposedly similar niches but with totally different zoogeographic origins, arrival times on the peninsula, and behavioral patterns, come together here in a classical case of biological competition. P. floridanus, a Florida endemic, is completely restricted to scrub habitats, and so it occurs in some numbers on our scrub study area. P. gossypinus, a ubiquitous, generalized creature, is found in all but wet, grassy habitats, and so, as noted above, it, too, occurs on our scrub study area. Our results show P. floridanus (14/hec.) outnumbering P. gossypinus in the summer, losing

ground in the fall (floridanus density 11.7/hec.), gossypinus in greater numbers in the winter (floridanus density 3.9/hec.), and exactly equal numbers (3.9/hec.) in the spring. Average weight of the floridanus population varied from 36.7 gr. in the summer, to 28.3 gr. in the fall, 34.6 in the winter, and 29.8 gr. in the spring. Sex ratios in the floridanus population were essentially at unity in all seasons except the spring, when females outnumbered males 4 to 1. P. floridanus had begun to breed in the summer (2 of 28 individuals were juveniles) but most reproduction occurred in the fall (9 of 30 were juveniles).

O. nuttalli also occurs in the Merritt Island scrub but thus far we have only captured it sporadically and in small numbers.

The only important small mammal of the Spartina marsh (our third major study area) is the rice rat, Oryzomys palustris. Fig. 7 summarizes the trends in small mammal population densities in the marsh and shows that Sigmodon also occurs there. It appears now, however, that cotton rats only move into the comparatively drier eastern edge of the marsh during times when that area is not covered by water and when Sigmodon densities are very high in surrounding areas. Oryzomys, on the other hand, is a true marsh dweller, equipped structurally and behaviorally for life in and around water. It is a difficult animal to trap, however, and we are somewhat less confident that the results obtained thus far (Fig. 7) represent trends in the natural population as well as our samplings of Sigmodon and Peromyocus populations do. Although additional trapping data are needed to clarify this situation, results thus far show that Oryzomys densities are at least as high as 5.5/hec. in the

summer, 3.7/hec. in the fall, 7.0/hec. in the winter, and 0.7/hec. in the spring. Average weights of Spartina marsh rice rats ranged from 56.3 gr. in the summer to 72.6 gr. in the fall, and 67.8 gr. in the winter. The only rice rats captured in the spring were one juvenile and one young adult. They averaged 35.0 gr. and indicate that at least some limited breeding had occurred in the spring. There is apparently a large breeding peak in late summer because 5 of 15 rice rats caught in September were juveniles. No juveniles were caught in the fall or winter. Sex ratios favored males 2:1 and 2.3:1 in the summer and fall, respectively. It was essentially at unity in the winter and too few animals were captured in the spring to make meaningful comparisons.

Survivorship

It is apparent that small mammal population densities can vary tremendously from season to season. One of the practical matters (from the point of view of impact statements, future comparisons, etc.) that this suggests is the matter of survivorship of individuals. The basic question here is: "How many of those animals known to be marked and alive at the end of one season can, under normal conditions, be expected to be present in the following season?" The answer, as Figs. 8 , 9 , and 10 show is that the proportion can be quite small. In the flatwoods, interseasonal survival is fairly uniform, varying between 17% and 20% in Sigmodon. It is higher for P. gossypinus (37.5% and 25%), at least during those periods for which we have adequate data. Note that the large asterisk in Fig. 8 indicates inadequately small numbers.

In the scrub (Fig. 9), P. gossypinus shows a high rate of survival from fall to winter (60%), not so high from winter to spring (40%). This is quite the opposite from the case of P. floridanus which shows a fairly

high rate from winter to spring (55.6%).

In the marsh, Oryzomys survival remains somewhat constant (20% and 40%) until the winter-spring transition, when it decreases drastically to zero.

Spatial Activity

The home range concept has been somewhat "overworked" in its traditional applications but continues to be useful when one begins to look into the possible causes of population fluctuation. Older methods present a number of problems, including wasting of data (linear captures, etc.) but the concept can still be useful. It seems reasonable, for example, that if food availability is involved in density changes, one might expect to find animals occupying large home ranges when densities are low and smaller ones when they are high.

Figures 11 and 12 summarize the information concerning home range that has been derived thus far. Note that a statistical rather than spatial method is used. It uses the unit, "mean distance between successive captures," as a statistical approximation to home range and allows one to put data to better use. Statistical comparisons of home range size were made between seasons within habitats.

The results, briefly stated, are these: 1) the only significant difference in apparent home range size is that between Sigmodon ranges in the summer and winter in the flatwoods and it is significantly smaller in the winter, when population densities are low. 2) In none of the other comparisons are the differences significant; both species of Peromyscus, for example, show great uniformity in home range size throughout the year, where adequate data are available.

Although many other factors need to be considered, these results tend to indicate that changes in food availability are not the proximate

cause of population fluctuation.

Preliminary Studies of Neofiber alleni.

One of the most interesting small mammals on Merritt Island is Neofiber alleni. Although it is on the rare and endangered species list, it occurs in some numbers in certain salt hay marshes on the island. These occur, generally, on parts of the refuge on the periphery of our area of major concern and so we have been unable to devote much time to the study of Neofiber.

Table 13 is a brief summary of the pilot study that we undertook in the fall of 1972. The results testify to the difficulty of trapping Neofiber alive (1000 trap nights, 18 captures). If time and suitable baits can be found, we should be able to add to our knowledge of this poorly known animal during 1973-74.

Characteristics of Large Mammal Populations.

Table 14 summarizes the results of our studies of raccoons, opossums, and spotted skunks from June to February, in the interior of the island and on dikes surrounding the impoundments. Note that there are no significant differences in size between male and female raccoons or opossums as indicated by weight or hind foot length. Also, because of the difficulty of determining the sex of live spotted skunks we are not positive of the sex of some that were captured at the very beginning of the study. For that reason the sexes are simply lumped for these earliest captures (Table 14).

Originally it was expected that our trapping program on the coastal strand would involve us primarily with raccoons and only to a lesser extent with opossums and spotted skunks. We were somewhat surprised by the large number of spotted skunks (Spilogale) that were captured (Table 15). Raccoons and opossums (and 2 species

of rabbits) were also taken (Table 15) but not nearly as frequently as spotted skunks. The data thus far derived concerning opossums and raccoons is generally comparable to that from interior populations but the trapping success and recapture frequency of spotted skunks (90 individuals captured a total of 346 times) has given us one of the finest opportunities to study this little known animal ever encountered.

The trappability of Spilogale is shown in Fig. 13. In the first seven days of trapping we had 100% recaptures on the 5th, 6th, and 7th days. Considering this together with the fact that we are dealing with a section of land essentially isolated by physical boundaries, it gives one of the best estimates of spotted skunk population densities possible. That unadjusted estimate (by enumeration) is 18.9 per $km.^2$

However, female skunks differ markedly from males in trap response and patterns of spatial activity. Trap-revealed sex ratios favored males significantly and the frequency of recapture of females known to be present was significantly lower than that of males. Females exhibited significantly smaller average distances between successive captures (144 m) than males (335 m) and markedly shorter Maximum Range Lengths. MRL averaged 282 m for females and 1332 m for males. These data suggest that our unadjusted population density calculation is an underestimate as a result of the comparatively reduced trappability and mobility, and smaller home range size of females. An adjusted density estimate (based on the assumption of a 1:1 sex ratio) is 22 skunks per $km.^2$

Future Studies:

Priority items for the 1973-74 academic year are:

1) Continued study of small mammal population dynamics in the flatwoods, scrub, and freshwater marsh.

2) The beginning of small mammal studies in a fourth major community type, the hardwood hammock.

3) Increased effort in the study of Neofiber alleni.

4) Continued emphasis on large mammal studies on the coastal strand "study area."

5) Increased emphasis on the larger, more difficult-to-study carnivores such as bob cats, otters, and foxes.

BIRD STUDIES

One group of organisms to which we have given less attention than we would like is that of the birds. We made the decision to place less emphasis on birds fairly early, when it became clear that various bird species were of particular interest to FWS personnel and that our permits would not allow us to take bird specimens. Later, when it became apparent that we might be asked about ecological considerations involved in the construction of the Shuttle Runway, we realized that we needed at least some information about the birds in the area. Accordingly, we assigned one of our research assistants who is extremely well-trained in bird identification to the task of making a bird census in the area that will be affected by the runway. The following is his report.

Introductory Summary

Between June 26, 1973 and August 7, 1973, I conducted a census of b rd species within a selected area of the Merritt Island National Wildlife Refuge.

Five to seven hours were spent each Tuesday and Thursday, between the above dates, observing and recording bird species. Approximately eighty manhours were spent in the field while conducting the census.

The selected area for this census is indicated by the shaded portion of the map (Fig. 14) This area has been chosen by the National Aeronautics and Space Administration as the probable construction site of the Space Shuttle runway. Construction is scheduled to begin in early 1974. The runway right-of-way has been partially cleared of vegetation and surveying is now being done in the area.

There are fewer birds and fewer species of birds in Florida in the summer than at any other time of year. There are virtually no waterfowl or warblers here during the summer months.

Approximately seventy bird species were observed inside of the selected area, with an additional 15 to 20 species seen outside of but near the selected area.

I have included an Appendix that consists of an annotated listing of all species observed within the census study area. A separate list is included indicating those species found near but not inside of the study area.

Location and Plant Associations

The specific location of the census study area is as follows:

North Boundary - SR 402 (Beach Road)

East Boundary - SR 3 (Kennedy Parkway North)

South Boundary - North shore of Banana Creek

West Boundary - Wisconsin Village Road

The census area lies north and west of the Vehicle Assembly Building and is approximately seven-square miles in area. All of the selected area is contained within Sections 26, 27, 28, 33, 34, 35 and 36 of Range 36 East, Township 21 South and Sections 1, 2, 3, 10, 11 and 12 of Range 36 East, Township 22 South.

There are a variety of plant associations contained in the study area and each will be listed with respect to birds observed and relative abundance by species of birds found in each major type of association.

The majority of the vegetation found within the area consists of pine flatwoods. This type of plant association covers most of the northern portion of the area and is well-represented in the southern portion. The second most common type of plant association is a palm-oak-wax mixture that dominates the central part of the study area and is common in the south-central part.

There are three other major plant associations within the study area: spartina salt marsh - southwest corner; oak-maple-palm hammock -

near and parallel to SR 3 (running from south to central portion), and a saline palm-grass savanna along the southern boundary (Banana Creek).

Additional associations within the census area are ruderal grass, salt pond margin, scrubby flatwoods, distichilis marsh and occasional foundation and Australian pine areas.

Those associations that will be discussed in connection with bird species/abundance are as follows: pine flatwoods, palm-oak-wax myrtle, oak-maple-palm hammock and palm-grass savanna (saline/hydric area). Methods. My methods used for collecting data on species and abundance of birds were varied. Where visibility was good and walking was not too difficult (as in pine and scrubby flatwoods), I walked as straight a line as was practical and stopped at set intervals, usually every fifty meters or so. During the stops, which lasted from two to five minutes, I listened for, watched and recorded each bird species observed, as well as noting numbers of each species. Extrapolation based on size of similar associations contained within the area provided data on relative abundance. There is typically little diversity of species in pine and scrubby flatwoods areas, so other than overflights, few species were noted or expected in these areas.

In the hammock areas, some of which are quite dense, walking was difficult to impossible. Here I penetrated into the hammocks as far as possible from various access roads and did most of my "observation" by listening. Most birds typically found in hammocks in the summer (Carolina Wren, Cardinal, Vireo, etc.) have easily identifiable songs. Extensive searching with binoculars in the hammock areas proved very productive in listing a large variety of birds.

I traveled on all of the passable roads that are within, near or that border the census area and added many species to the total species

count by noting birds on power lines, roadsides and ditches.

On two occasions a canoe was used to travel along the southern boundary of the study area in brackish water impoundments that have been created as a result of dike construction along the north shore of Banana Creek. Many wading birds were observed on these occasions.

Birds Within Selected Area

Pine Flatwoods. This kind of plant association along with the similar Scrubby Flatwoods areas is poor in species diversity. There is typically little or no standing water in such areas. Most of the biota that occurs here is adapted to a dry-hot environment. The plants give up little moisture and the soil is very sandy.

The birds that occur here must necessarily be those that can withstand the rigors of such an area. Few species seem able to do well in this hostile environment. Other than a few scattered pines and small high hammocks (which are actually subassociations and are not to be included in the description of a Pine Flatwoods association), these areas are treeless and consist mainly of saw-palmetto and other hard or waxy surface leaved plants.

Birds that I found here were mainly seed eaters such as Towhees, Cardinals, Scrub Jays and occasional Red-winged Blackbirds. In any small thicket or group of scrub oaks or hickories, I invariably found White-eyed Vireos, Yellowthroats and in the taller pines, Red-bellied Woodpeckers.

By far the most common bird found in all of the pine and scrubby flatwoods was the Rufous-sided Towhee. This bird eats virtually nothing except grass and weed seeds ("scratch feed") that abound in these areas.

Ground and mourning doves were also occasionally encountered in the flatwoods areas, especially in portions that bordered other, wetter associations.

Palm-Oak-Wax Myrtle Areas. This kind of association, which is the second most common type area, is more diverse in species of birds (as well as other life forms). Here all of the birds I found in the flatwoods were present along with several other well-represented species. The birds found here were more diverse in food preference. All of the flatwoods birds plus Mockingbirds, prairie Warblers, Grackles (both), Savannah Sparrows and occasional Carolina Wrens, Loggerhead Shrikes and Eastern Kingbirds were in evidence.

The most common bird in the Palm-Oak-Wax Myrtle associations was again the Towhee, but others such as White-eyed Vireos, Yellowthroats and Scrub Jays were also very commonly seen here.

Palm-Grass Savanna (Saline/Hydric areas). This kind of association is dominant along the entire southern border of the study area. Visibility here is excellent but access is usually difficult. Walking in the salt grasses is difficult because of constantly changing water levels (from dry to deep).

The Palm-Grass Savanna areas were best observed from the numerous dikes and dirt roads that transect them. Wherever possible, I walked on and in these areas but where I could not, visibility was usually good enough to provide productive observation scanning with telescope and binoculars.

Several species were observed in these areas that were not seen in other parts of the study area. Many others were much more common here than elsewhere. Common birds of the savanna areas include Tree Swallows, Turkey and Black Vultures, Laughing, Ring-billed and Herring Gulls, Royal terns, Brown Pelicans, Wood Storks, White and Glossy Ibis and most of the Egrets and Herons. All of the birds above were observed flying overhead while I was in the savanna areas.

Explanation of Appendices

Appendix I — An annotated listing of only those bird species observed within the described census study area. Contains notes on unusual sightings or numbers of birds.

Appendix II — An annotated listing of birds observed outside of the described census study area. None of the birds listed here were observed inside of the study area.

Appendix III — A listing of all birds observed both inside and outside of census study area. A number following a listed species indicates the total number of that species observed during the entire census. The absence of such a notation indicates that that species was too numerous to count.

APPENDIX I

An Annotated List of Birds Found Within Census Areas

Pied-billed Grebe – Several seen, more seen in winter.

Brown Pelican – Seen at southern edge of area (near Banana Creek)

Double-crested Cormorant – Usually observed flying overhead

Anhinga – Observed flying over southern section and in mangrove trees

Great Blue Heron – Common throughout southern one-third of area

Green Heron – Very common in and near impoundments near Banana Creek

Little Blue Heron – Several seen along Banana Creek and impoundments

Cattle Egret – Abundant along mowed roadside grass

Great Egret – Often seen overhead and in salt marshes

Snowy Egret – Usually seen in and near small ponds and ditches

Louisiana Heron – Abundant in southern one-half of area

Black-crowned Night Heron – Probably six to eight seen in vicinity of Banana Creek

Yellow-crowned Night Heron – Several seen near water and in mangroves – more than expected

Least Bittern – Two seen along dike north of Banana Creek

Wood Stork – Commonly seen overhead everywhere in study area

Glossy Ibis – Much more common than expected – seen singly or in small flocks

White Ibis – Very common – sometimes seen flying in flocks or 20 or more

Mottled Duck – Very common in salt and brackish impoundments

Blue-winged teal – One seen flying with mottled ducks

Wood Duck – Possibly seen in hammock area (not seen well enough for positive identification)

Turkey Vulture – Abundant over entire area

Black Vulture – Common over most of area

Red-tailed Hawk – Several (5-15) seen in area – mostly on power lines along SR 3 and SR 402

Red-shouldered Hawk – Two seen – one on power line on SR3, other in pine tree near dense central hammock

Bald Eagle – Two seen at once – over Banana Creek

Osprey – At least three seen – near Banana Creek/SR 3 area

Sparrow Hawk – One seen on last day of observation (August 7, 1973) on power line on SR 3

Bobwhite – Common in scrubby areas and near hammocks

King Rail – One seen – several heard in impounded areas

Clapper Rail – Many heard near Banana Creek in salt-marsh

Common Gallinule – Common in water north of Banana Creek

American Coot – Only several seen – much more common in winter

Wilson's Plover – One seen in ditch beside SR 3 – unusual in winter

Killdeer – Common in prairie and savanna areas

Spotted Sandpiper – One seen in ditch beside SR 3 – unusual for winter

Willet – Several seen on mudflats near impoundments north of Banana Creek

Black-necked Stilt – Common along Banana Creek

Herring Gull – Few overhead near Banana Creek

Ring-billed Gull – Very common over and near Banana Creek

Laughing Gull – Many seen in southern portion of area

Gull-billed Tern – One seen flying over impoundment north of Banana Creek

Least Tern – Many seen over Banana Creek and impoundments

Royal Tern – Several seen near Banana Creek

Mourning Dove – Common in dryer portions of study area

Ground Dove – Common along dikes and dirt roads throughout study area

Yellow-billed Cuckoo – Much more common than expected – probably 40+ birds heard and seen in hammock and thicket areas

Smooth-billed Ani – One heard and one possible sighting just north of Banana Creek on dike

Barred Owl – Several heard in hammocks

Chuck-will's Widow – Many heard in early morning in flatwoods areas

Common Nighthawk – Several seen and heard along SR 3 and SR 402 in early morning

Ruby-throated Hummingbird – One seen in dense hammock area near center of study area

Belted Kingfisher – A few seen in last two days of observation – on power lines along SR 3

Pileated Woodpecker – Five seen in and near dense hammock

Red-bellied Woodpecker – Common in pine flatwoods and hammock areas

Eastern Kingbird – Several seen in palm-oak-wax myrtle areas

Great Crested Flycatcher – Three observed at a mixed palm-oak-wax myrtle/hammock area

Tree Swallow – Seen overhead over most of study area – usually in very small (3 to 10) groups

Blue Jay – Near SR 3

Scrub Jay – Locally common (in loose flocks) in flatwoods areas

Fish Crow – Common over most wet areas in southern portion

Carolina Wren – Abundant (many singing) in hammock areas

Mockingbird – Common in dry areas

Loggerhead Shrike – Several seen in palm-oak-wax myrtle associations

White-eyed Vireo – Very common in thickets and hammocks

Black-whiskered Vireo – One observed in dense hammock near center of area

Prairie Warbler – Several singing males along Banana Creek

Yellowthroat – Common in dry areas

Eastern Meadowlark – Many in grass along SR 3

Red-winged Blackbird – Common in southern, wet, portion

Boat-tailed Grackle – Common near water

Common Grackle – Fairly common throughout

Summer Tanager – One observed in dense hammock in central portion of area

Cardinal – Many seen and heard throughout drier areas and hammocks

Rufous-sided Towhee – Ubiquitous in dry areas

Savannah Sparrow – Usually seen along dikes and smaller dirt roads

APPENDIX II

An Annotated List of Birds Found Outside of Census Area

Note: Location of sighting of each bird is noted. None of the species below were seen inside of the census area

White Pelican – Sections 13 and 24, R35E, T21S – approximately 10 seen

Magnificent Frigate-bird – Playalinda Beach – one seen

Reddish Egret – Section 33, R36E, T20S – one seen, edge of Mosquito Lagoon

Roseate Spoonbill – Approximately 50 birds flying over Lab – August 7, 8:00 a.m., plus one at Camera Pad 10, Playalinda Beach

Lesser Scaup – Section 13, R35E, T20S – one seen, unable to fly

Greater Yellowlegs – Section 13, R35E, T20S, two seen

Lesser Yellowlegs – Section 13, R35E, T20S – six to eight seen

Sanderling – Section 13, R35E, T20S – ten seen

Black Tern – Section 13, R35E, T20S – four seen in company with approximately fifty least terns

Black Skimmer – Section 13, R36E, T20S – one seen over Mosquito Lagoon

Ruddy Turnstone – On Playalinda Beach, south end – two seen

Downy Woodpecker – Section 33, R36E, T20S – one seen in Dummit Grove area

Gray Kingbird – Near Camera Pad 10, Playalinda Beach – three seen

Starling – Flying over Lab – approximately twenty birds

House Sparrow – VAB parking areas

APPENDIX III

A Listing of All Birds Observed Both Inside and Outside of Census Study Area

Pied-billed Grebe (10)
White Pelican (10)
Brown Pelican (25)
Double-crested Cormorant
Anhinga (15)
Magnificent Frigate-bird (1)
Great Blue Heron
Green Heron
Little Blue Heron (15)
Cattle Egret
Reddish Egret (1)
Great Egret
Snowy Egret
Louisiana Heron
Black-crowned Night Heron (7)
Yellow-crowned Night Heron (4)
Least Bittern (3)
Wood Stork
Glossy Ibis
White Ibis
Roseate Spoonbill (50+)
Mottled Duck
Blue-winged Teal (1)
Wood Duck (?)
Lesser Scaup (1)
Turkey Vulture
Black Vulture
Red-tailed Hawk (8)
Red-shouldered Hawk (2)
Bald Eagle (2)
Osprey (3)
Sparrow Hawk (1)
Bobwhite
King Rail (5)
Clapper Rail (12)
Common Gallinule
American Coot (15)
Wilson's Plover (1)
Killdeer
Ruddy Turnstone (2)
Spotted Sandpiper (1)
Willet (15)
Greater Yellowlegs (2)

Lesser Yellowlegs (7)
Sanderling (10)
Black-necked Stilt
Herring Gull (5)
Ring-billed Gull
Laughing Gull
Gull-billed Tern (2)
Least Tern
Royal Tern
Black Tern (4)
Black Skimmer (1)
Morning Dove
Ground Dove
Yellow-billed Cuckoo (40+)
Smooth-billed Ani (1)
Barred Owl (3)
Chuck-will's Widow
Common Nighthawk
Ruby-throated Hummingbird (1)
Belted Kingfisher (3)
Pileated Woodpecker (5)
Red-bellied Woodpecker
Downy Woodpecker (1)
Eastern Kingbird
Gray Kingbird (3)
Great Crested Flycatcher (3)
Tree Swallow
Blue Jay
Scrub Jay
Fish Crow
Carolina Wren
Mockingbird
Loggerhead Shrike
Starling (20)
White-eyed Vireo
Black-whiskered Vireo (1)
Prairie Warbler
Yellowthroat
House Sparrow
Eastern Meadowlark
Red-winged Blackbird
Boat-tailed Grackle
Common Grackle
Summer Tanager (1)
Cardinal
Rufous-sided Towhee
Savannah Sparrow

AMPHIBIAN AND REPTILE STUDIES

Although we have not been able to devote time and resources to intensive studies of amphibians and reptiles, we feel that we have a reasonable qualitative understanding of the herptile fauna of Merritt Island. An annotated list of species is presented in Table 16 .

Amphibia. To date we have not encountered any Urodeles on Merritt Island, but few attempts at collecting them have been made. One or more species of salamanders and/or sirens may be present.

Because of extensive wetland acreage frogs are abundant on Merritt Island and they are very important in providing a dependable food supply for many larger predators. As a consequence of considerable diveristy in breeding time and habitat preference in the frog fauna, nearly every habitat has at least one species of frog active during each season of the year.

The two most common frogs of the Island are Acris gryllus and Hyla ocularis. Both are extremely common throughout the Florida peninsula and it is not surprising to find them in abundance in our study area.

The most common climbing hylid frog is Hyla cinerea. It is much more abundant on Merritt Island, in marshes and wetlands particularly, than is Hyla squirella. This is opposite from the situation on the mainland, where H. squirella is usually encountered in greater abundance than H. cinerea. In one of our major study areas, the Spartina marsh, there is a large population of H. cinerea and we have been

making systematic collections for later analysis of morphometric characters and stomach contents.

The three most common frogs in the flatwoods and mixed scrub associations are Bufo quercicus, Hyla femoralis, and Pseudacris nigrita. The first two are encountered throughout the year but P. nigrita is extremely inconspicuous except when it migrates to breeding ponds during the winter. We were able to take two good samples during February.

Relatively little survey work has been conducted in the hammock plant communities to date. Our incidental studies have revealed that hammocks harbor good populations of an introduced frog, the small Eleutherodactylus ricordi. The single specimen of Hyla gratiosa we have discovered also came from a hammock.

Reptilia. Our reptile species list includes 6 lizards, 20 snakes, 11 turtles, and the alligator.

The most common lizards on Merritt Island are Anolis carolinensis and Cnemidophorus sexlineatus. Both occur in a variety of terrestrial habitats but the latter species is especially characteristic of scrub and flatwoods communities. The glass lizard, Ophisaurus ventralis, is also a lizard characteristic of these more xeric areas, especially the flatwoods. It is probably more abundant than our captures suggest since its habit of burrowing beneath the thick ground litter renders it difficult to locate. Conspicuous by their absence are two species of Sceloporus, S. woodei and S. undulatus. Both species are common in appropriate habitats in peninsular Florida but have not yet been

discovered in similar habitats on Merritt Island.

Snakes are both speciose and abundant on the Island. The most frequently encountered nonpoisonous snakes are the diurnally active black racer (Coluber constrictor) and ribbon snake (Thamnophis sauritus). Both occur in almost all types of habitats and are significant predators on frogs and lizards.

Small, secretive, largely nocturnal snake species, such as Cemophora coccinea and Liodytes alleni, are poorly represented in our samples but may be more common than suggested. Likewise, nocturnal, secretive species that have not yet been found on the Island (Rhadinea flavillata and Lampropeltis triangulum for example) may actually be present. We have no explanation for the absence of both species of the conspicuous hognose snakes (Heterodon).

Crotalid snakes are abundant on Merritt Island. Our records indicate that both the diamondback rattlesnake and the cottonmouth are encountered more frequently than even the ubiquitous black racer. The diamondback is characteristic of xeric areas, the cottonmouth is found in hydric areas. Together they play a significant role in controlling populations of smaller prey vertebrates throughout the island.

Turtles are an important component of the vertebrate fauna. Due to the abundance of appropriate habitats, aquatic turtles are common although not generally encountered until they move into terrestrial areas. Our two terrestrial turtles, Terrapene carolina and Gopherus polyphemus, are numerous in almost all habitats. The gopher turtle plays an especially significant role in the ecology of our scrub and flatwoods study areas due to its construction of conspicuous burrows

that provide living space and refugia from heat for several mammal, reptile, and amphibian species.

We have initiated a mark-release program on terrestrial turtles. Each turtle caught is sexed, weighed, and measured and then is given an individual coded mark by drilling small holes through the marginal scutes. Thus far we have marked and released about 75 turtles. Returns or recaptures have been too few to give any meaningful results as yet.

Marine Turtle Studies. During the last week in May marine turtles, primarily loggerheads (Caretta caretta), began coming ashore to deposit eggs on Merritt Island beaches. In a continuing cooperative effort with the Fish and Wildlife Service and with tags supplied by Dr. Archie Carr of the University of Florida, we have tagged, weighed, and measured loggerheads and marked their nest sites two nights per week from the end of May to the date of this writing. It is strictly a volunteer effort on the part of FWS personnel and our crew members (most of the work is done at night, of course) but we feel that the loggerheads represent a unique feature of the Merritt Island Refuge and fall within our greater charge to characterize the flora and fauna of the island. Table 17 is a summary of our activities to date. We have tagged 39 loggerheads and have recorded 2 recaptures.

There are almost no published records of the weights of loggerheads. Although it is time consuming, we are getting good weight determinations through use of a rig constructed by FWS personnel on the back of a "dune buggy." Also,to our knowledge, there are no published accounts of loggerheads nesting on Merritt Island or Cape Kennedy, although it

is well known locally that they do. It now appears that the Merritt Island-KSC area is now established as a fourth major loggerhead rookery on the coast of North America, along with Cape Romain, S.C.; Jekyll Island, Ga.; and Hutchinson's Island, Martin Co., Florida .

One result that we have seen thus far is that there is a very constant linear regression of the weights of loggerheads on linear measurements of the carapace and plastron. Figure 15 shows this relationship and the extremely good fit of these lines to the data. The correlation coefficients are very high (.92 and .93) so that these relationships can be quite useful in predicting weights of these turtles from linear measurements.

Future Study: If adequate resources are available we hope to expand our study of amphibian and reptile species to include some or all of the following:

1) Autecological analysis of the large Hyla cinerea population on our Spartina marsh study area;
2) Analysis of the food habits of the more common reptile species present on our terrestrial study areas;
3) An attempt to obtain quantitative abundance data on snakes, frogs, and other small vertebrates that can be induced to hide beneath artificially created cover.
4) Expand survey efforts in additional areas, using techniques designed to gain information on the distribution and abundance of rare or poorly known herptiles.

5) Document breeding times of important frog species and correlate these with meterological and environmental conditions.

Our incidental survey effort will continue, providing material for many types of future studies. Our tagging program of terrestrial turtles will continue and we anticipate that meaningful results should be forthcoming by Fall, 1974.

FISH STUDIES

The first phase of the fish investigations was devoted to a general qualitative survey of Merritt Island to determine the types of habitats present, the fish species present, and their general distribution and abundance. To date over 70 fish samples have been taken and over 38,000 fish specimens have been identified and examined.

Methods. Methods used in obtaining fish samples include the following: dip net, seine nets, gill nets, cast nets, minnow traps, hook and line fishing, and trot line fishing. The standard collecting gear employed at most study sites and regularly at our permanent study stations is a nylon minnow seine 3.7 meters long, 1.2 meters deep, with 4.5 millimeter bar mesh. When water clarity permits, ponds are visually reconnoitered using diving techniques.

Relative abundance of fishes is evaluated by numbers of individuals of each species caught per minute of seining time. The time the seine is being hauled is accumulated with a stop watch. A minimum seining time of two minutes per station was established as a base.

All fishes are fixed in 10% formalin for about ten days and are subsequently stored in 40% isopropanol. All specimen examination is accomplished in the laboratory under a dissecting microscope.

The emphasis of fish ecological work thus far has been on smaller species. Small species are susceptible to our sampling techniques and can be collected in statistically meaningful numbers

without affecting the health of the population. In addition, the great abundance of small fishes on Merritt Island attests to their key role in all aquatic systems. Although large fish species are not ignored, the special techniques necessary for securing and handling adequate numbers of specimens pose logistic problems.

Aquatic Habitats. Merritt Island was originally bordered along most of its western and northwestern shore by extensive brackish-water Spartina marsh. On the interior of the island there were probably few or no permanent bodies of fresh surface water. Although ephemeral creeks and flooded catchment basins were present during rainy periods, they were relatively unimportant as fish habitats.

Two events have altered the natural aquatic ecology of Merritt Island. The first was the construction of dikes for mosquito control. Dikes were erected around almost the entire western periphery of the island, converting salt marsh into a series of shallow brackish-water impoundments, each with a very small drainage basin. The second altering event was the digging of borrow pits and ditches to provide fill for the construction of roads and, later, the NASA installations. These borrow areas have created permanent surface reservoirs of fresh water on the interior of the Island.

The aquatic habitats on Merritt Island may conveniently be divided into four types. Although this classification is oversimplification of the diversity of aquatic habitats, it corresponds well with the distribution of the limited fish fauna.

Type I. Low catch basins hold water for only a relatively limited period of time. Two extremes can be identified, corresponding closely to the "Grass Pond Swales" and "Fresh Spartina Marsh" plant communities identified elsewhere in this report by Dr. Haven Sweet. The smaller, more-ephemeral swales may be flooded only during brief rainy periods or during one season of the year. Vegetation is usually heavy; characteristic plant species are noted elsewhere in this report. Low grassy swales are widely scattered throughout the higher interior areas of Merritt Island.

Low catch basins of greater areal extent, the fresh Spartina marshes, are characterized by a different plant assembledge (see listing elsewhere) because of their greater water holding capacity. Such areas may be inundated throughout an unusually wet year, but recede drastically or dry up completely during normal or dry periods.

Because of their ephemeral nature, flooded catch basins are relatively unimportant as fish habitats and no clear ichthyological distinction can be drawn between the two extreme types. Several species, including Gambusia affinis, Heterandria formosa, and Jordanella floridae may invade these flooded areas from adjacent permanent bodies of water but reproducing populations are seldom established before desiccation begins.

Type II. Roadside or dike-side ditches are man-made habitats excavated while providing material for road or dike construction. Most of these ditches, especially the deeper ones, are relatively permanent features of the landscape. These ditches typically contain

fresh water and are heavily vegetated in shallower portions. Characteristic plants are arrow leaf (Sagittaria), cattail (Typha), bladderwort (Utricularia), Najas, and Ludwigia. The surface of the water may occasionally be covered with duckweed (Lemna) and/or water fern (Azolla). Ditches are very productive of fishes. Some characteristic species are: Gambusia affinis, Heterandria formosa, Fundulus chrysotus, Lucania goodei, Notemigonus crysoleucas, Lepomis gulosus, Lepomis macrochirus, and Micropterus salmoides.

Type III. Borrow pits are excavated in the digging of fill for construction base. These basins quickly fill with water due to the height of the water table and become borrow ponds. Borrow ponds on Merritt Island vary in size and depth. Color, hardness, and probably other physio-chemical parameters of borrow pond water vary with the nature of soil leachate and surface water runoff.

The borrow ponds on Merritt Island have very steep sides, dropping abruptly down to a water depth of two to three meters. As a result these ponds have very little productive littoral zone and virtually no cover for fishes. Some of the clearer ponds with hard water may have sufficient light growth over most of the bottom. However, most borrow ponds have darker, more poorly buffered water. The only vegetation in such ponds is a narrow peripheral stand of cattails (Typha). As a whole, borrow ponds are rather unproductive fish habitats.

Type IV. The last class of aquatic habitats are impoundments. A great variety of ecological stiuations are lumped under this one heading because every impoundment is somewhat distinct in its physio-chemical and biological parameters.

Impoundments are diked on at least three sides; the side nearest the center of the Island may be diked or not. Water in the interior of impoundments is usually quite shallow, averaging less than one meter. Around the periphery of the impoundments is a dike-side canal excavated in providing material for the dike. These canals are two to three meters deep and three to six meters wide. Bottom sediments are usually thick organic silt. Water levels in impoundments fluctuate relatively little and are manipulated by pumping lagoonal water into them during low water periods or opening water control structures during high water. The water in most impoundments is brackish, but ranges from fresh up to a maximum salinity of 31 ppt.

A great deal of diversity exists in the type and amount of vegetation present in these impoundments. This vegetation is partially correlated with the nature of the area before inundation and water salinity. Some low salinity impoundments are nearly covered with surface mats of salt hay, Distichlis and Paspalum. Pockets of open water may be very limited. Other low salinity impoundments lack a surface mat but have abundant rooted submerged and emergent vegetation - Spartina alternifolia, widgeon grass (Ruppia), and Chara. The growth of Chara during warmer months may choke off certain impoundments from bottom to surface. At higher salinities, aquatic vegetation becomes

much less dominant. Most high salinity impoundments represent diked salt marsh. The only aquatic vegetation in such impoundments is scattered clumps of Spartina bakeri (bunch grass) and sparse, scattered growths of widgeon grass (Ruppia) and Chara. There are large expanses of open water lacking plants or cover of any type.

The fish fauna of the impoundments is very depauperate. The typical brackish impoundment supports about ten fish species, the dominant six in all cases being Cyprinodon variegatus, Fundulus grandis, Lucania parva, Gambusia affinis, Poecilia latipinna, and Menidia beryllina. The dike-side canals around the periphery of the impoundments provide limited habitat for a few large fishes (Lepisosteus platyrhincus, Mugil cephalus, and various centrarchids) and a refuge for small fishes when the water level in the interior of the impoundment drops.

Fish Fauna. In general, all aquatic habitats on Merritt Island are relatively harsh environments. Few species of fishes are adapted to the fluctuating water levels, varying salinities, high summer temperatures, and the exposure characteristic of most aquatic situations on the Island. Consequently, the fish fauna of Merritt Island is depauperate. There are several fresh water fishes common in peninsular Florida that are not found in the fresh waters of Merritt Island; there are many marine fishes characteristic of the surrounding lagoons that are not present in the brackish waters on the interior of the Island.

Our survey to date has disclosed 31 fish species, listed in Table 18 . Several of the species are estuarine fishes that do not maintain permanent populations within our study area but occur only

as sporadic immigrants. Several other species, including most of the large sunfishes (Lepomis - sp.), the largemouth bass (Micropterus salmoides), and the golden shiner (Notemigonus crysoleucas) have been accidentally released or purposefully stocked in the Island's waters.

Excluding these species, the fauna is composed almost entirely of members of the order Atheriniformes - the silversides, killifishes, and livebearers. The fishes of this group are adapted to and characteristic of harsh marginal environments throughout the warmer parts of the United States. They thrive in the rigorous environments on Merritt Island, their population densities often reaching astounding levels during favorable periods.

Ecological Distribution: Considering permanent bodies of water, the distribution of fishes on Merritt Island is controlled by two primary factors - salinity and vegetation.

An appended bar graph (Figure 16) depicts the salinity relations of ten species of Atheriniform fishes. Although most of these species are classified as euryhaline, they actually segregate themselves sharply on the basis of salinity. Cyprinodon variegatus, Lucania parva, Menidia beryllina, and Fundulus grandis have never been collected in fresh water but are generally present in all samples with a salinity greater than 6 ppt. Heterandria formosa, Jordanella floridae, Lucania goodei, and Fundulus chrysotus are generally present in all freshwater collections and are rarely present at salinities greater than 6 ppt. Habitats with a salinity range from 1-5 ppt. are the only areas where any significant degree of mixing occurs. In such habitats, fresh and

brackish water species occur together in unpredictable combinations of species. However, with the exception of Jordanella floridae, both fresh and brackish water species maintain low population densities in habitats in this salinity range.

Obvious from the histogram (Figure 16) are the two ubiquitous species, Gambusia affinis and Poecilia latipinna. They occur at all salinities in all habitats, and usually in large numbers.

Of the ten species shown in Figure 16 , three - Cyrinodon variegatus, Lucania parva, and Menidia beryllina - are species characteristic of open-water areas with little or no vegetative cover. The remaining seven species are all characteristic of heavily vegetated, shallow areas. This dichotomy is most distinct in brackish water impoundments. The fish fauna of all brackish impoundments is dominated by the same six species - Cyprinodon variegatus, Lucania parva, Menidia beryllina, Fundulus grandis, Poecilia latipinna, and Gambusia affinis; but the relative abundance of the species varies with the amount of vegetative cover. In sparsely vegetated impoundments, the first three species predominate, and the last two are uncommon; the reverse is true in heavily vegetated areas. Fundulus grandis is about equally common under both conditions.

Population Fluctuations. We selected four permanent study sites (Figure 1) representing different habitat types and began sampling these in the Fall of 1972 on a monthly basis. In addition to monitoring fluctuations in relative abundance of species, this sampling program has provided us with samples to be examined later for data on reproduction

and food habits.

Our data for this project are incompletely analyzed at present. For completeness, we have presented the rough data from three study sites in the appended Tables 19-21. Wilson's Corner ditch is a typical freshwater ditch. The VAB pond is a brackish water impoundment with considerable rooted aquatic vegetation. The T-24-B impoundment is a brackish impoundment containing very little vegetation of any type.

No conclusions can be drawn from this study as yet. In general, populations are high in the summer and low in the winter. Some species enter the sample only sporadically and then in low numbers. For almost all species collected regularly, the monthly estimates will stay within a fairly logical range of variation and then diverge radically up or down, without obvious explanation. We anticipate that it will take data from at least two years before patterns of population fluctuation become obvious.

Comparison of the data from the VAB pond (Table 19) and impoundment T-24-B (Table 20) supports the previous contention that amount of vegetative cover influences the relative abundance of certain species. Note also the drastic decline in abundance of most species in the winter samples from T-24-B. Fish were very difficult to locate during this period, probably a combined result of actual population decreases and a movement of fish out of our normal sample areas to deeper water.

Reproductive Studies. Last winter we became interested in the possibility of establishing base-line data on fish reproduction in hopes of finding other techniques for monitoring how a species responds to changes in

its environment. We chose the sailfin molly (Poecilia latipinna) as a study species for several reasons: (1) it is ubiquitous and abundant, (2) it is a livebearer, facilitating the determination of reproductive condition, and (3) for the purely academic reason that very little was known about reproduction in the species.

Since this study began, we have studied over 9000 specimens from two distinctively different populations of Poecilia. Samples are being taken on a bi-monthly basis from each population and we hope to continue this study for a minimum of two years. We are currently in the process of computerizing this data for analysis and, consequently, we cannot present conclusions or detailed analysis at present.

The parameters that are being analyzed are as follows:

1) sex ratio of juveniles and adults
2) size at maturation
3) length frequency of immature and mature males and females
4) number of females gravid (pregnant)
5) number of embryos per brood
6) embryo stage and its relationship with brood size and female size
7) numbers of unfertilized eggs or arrested embryos and their relationship to brood size and female size

All these features will be analyzed for possible relationships with physical and biological environmental features such as dissolved oxygen, water depth, water temperature, season, salinity, and available food resources.

Although this study has only recently been initiated and the data are not as yet analyzed, certain interesting things are apparent. For purposes of discussion, some of our data from one study population have been superficially tabulated in Table 22.

The sex ratio in this population varies from month to month; it is not consistently in favor of females as the literature reports to be the case in poeciliids. Also, reproduction had virtually ceased by October and did not resume until spring. This observation is contrary to usual opinion that poeciliids reproduce year round in peninsular Florida.

The gravid female data also reveal that the level of reproduction increased from April to May but dropped abruptly back to the April level in June. The decrease in June was associated with a severe drop in the water level in this impoundment. The winter and spring water level had been normal, filling the impoundment. Beginning in May, the water level began to drop and by June only a few deep holes contained water. The fish concentrated in these holes became stressed as daily water temperatures increased, plant growth became excessive, and the food supply dwindled. The relative abundance data (Table 19) reflect the concentrating effect in May and a rather drastic die-off in June.

This environmental stress is also reflected in the relationship between brood size and size of the female (Figure 17). As in most cases, the number of young produced increases with female size. The difference in slopes of the regression lines for the three months is not significant. Note, however, the size of reproductively active females (length of the regression lines) in May and June. By June, most larger females had succumbed and only small females were pregnant. Thus, not only were there

fewer reproductive females in June, those that were reproducing averaged smaller and thus produced fewer young per brood.

Our field study of molly reproduction is being enhanced and expanded by correlated laboratory studies under controlled conditions. This phase of the research is being conducted by Mr. Wallace W. Gee, a graduate student. (See GRADUATE STUDIES for a description of his thesis research).

As an undergraduate research project, Mr. Gee determined the gestation period (interbrood interval) in Poecilia under controlled environmental conditions that approximated summer water conditions in our natural study areas. Each of six 10 gal (38 liter) aquaria were subdivided into 5 equal size compartments by perforated plexiglass partitions. The tanks were maintained under a natural photoperiod at 32.5°C and 10 ppt. salinity. The fish were maintained over a 6 month period. Young born were recorded and removed daily. Based on 21 observations, the gestation period ranged from 21 to 31 days with a mean of 24.9.

Future Work

We do not anticipate any major expansion of ichthyological studies during the coming year. All investigations and programs currently in progress will continue uninterrupted. A major goal is to computerize all our reproductive data for storage and future analysis. We will continue to survey aquatic habitats throughout the island, using techniques suitable to the capture of poorly known species.

ANCILLARY STUDIES

The following is a brief summary of studies underway by graduate students affiliated with this grant. These studies are directed by one of the principal investigators and contribute significantly to our goal of understanding the ecology of Merritt Island.

Gestation Period and Sperm Storage: Aspects of Reproduction in Poecilia latipinna. This study is the current Masters thesis problem of Mr. Wallace W. Gee.

Mr. Gee is expanding and continuing his undergraduate research project in an attempt to answer questions raised by our field study of reproduction in the sailfin molly. Fishes will be maintained in the laboratory under controlled environmental conditions in order to learn more about the correlation of external environmental conditions and reproductive success. The following environmental parameters have either been identified in the literature or have suggested themselves during our field study as playing important roles in the control of reproduction: temperature, salinity, dissolved oxygen, and photoperiod.

In his previous work, Mr. Gee determined the gestation period of this species under one set of environmental conditions. In this study he will examine gestation period under a variety of environmental regimes involving the four parameters identified above. He will attempt to show to what extent development can be slowed or accelerated by environmental influence.

In general, developmental rates have been shown to increase with increasing temperature up to the point of lethal temperatures. However, our field data from a Poecilia population stressed by very high temperatures and low dissolved oxygen suggest that, under extreme conditions, development may be slowed or even suspended. Suspended development has been demonstrated for several species in the closely related family Cyprinodontidae, but has never been shown for the Poeciliidae. Mr. Gee will attempt to induce suspended

development in the laboratory in order to confirm our suspicion and to determine what combinations of environmental conditions are necessary to induce suspension.

Female Poecilia have the ability to store sperm in the ovary. Consequently, a female may give birth to several successive broods of living young after only one insemination. In this study Mr. Gee will investigate the influence of varying environmental conditions on the duration of storage of functional sperm. Our field studies suggest that functional sperm is not stored through the winter and that insemination is required to initiate reproduction in the spring.

A detailed understanding of the influence of various environmental conditions on developmental rate and sperm storage may prove to be a key to understanding the great success (both distributionally and numerically) of this species on Merritt Island.

Nest Building and food habits of the rice rat, Oryzomys Palustris, from Merritt Island, Florida. Master's thesis problem: M. H. Harrison.

The genus Oryzomys (Rodentia: Cricetidae) is distributed in wet marshy areas from New Jersey to Southern Illinois and then southward throughout South America. Despite this rather widespread distribution, little is known of its ecology and behavior.

Reasons for the paucity of information include the facts that rice rats are quite trap shy and leave almost no sign to indicate their presense in an area. I have found that the best way to insure trap success is to prebait an area for several days before trapping and have been able to trap rice rats in all of the wet areas of Merritt Island.

Thus far, my study has specifically dealt with the effects of temperature variation on nest building activity. Because of the established differences in the behavior of lab-reared and field-caught individuals and the known effects of the female reproductive cycles on nest building activity, I have used only field-caught, adult males for each experiment. I placed each of four such individuals in an experimental chamber. Four chambers were placed in a controlled environment growth chamber at one time; food and water were provided ad libitum. After one day for acclimation at 22° C, each rat was provided with cotton for a nesting material. Every day for 5 days the previous night's nest was removed and the nest weight was determined by weighing the unused cotton. The temperature was then lowered to 16°C, the mean January temperature in the area, and the rats were tested for five days as before. After one day at 22°C, the temperature was raised to 33°C, which is the mean July

temperature in the area, at which they were tested for 5 days. The rats were then returned to the point of capture and released. The preliminary results, after 112 nights in the environmental chamber, show no significant relationship between temperature and nest size at the 5% level of significance.

Contrary to the usual food preferences of Cricetine rodents, Oryzomys has been reported to prefer a carnivorous diet. I plan to report the food preferences of fresh-and brackish-water inhabitants by analysis of stomach contents.

Systematics and Comparative Ecology of Cyprinodon variegatus in Florida. This study is the current Masters thesis problem of Mr. William E. Johnson.

The purpose of this study is to investigate the systematics and comparative ecology of C. variegatus and C. hubbsi in Florida. Since C. hubbsi was first described, its status as a valid species and relation with C. variegatus have been in question. The range of C. hubbsi is limited to the headwaters of the Oklawaha River in central Florida. Because the ecological requirements of C. hubbsi are very narrow and the quality of the lakes which it inhabits have declined radically in recent years, the survival of C. hubbsi seems in jeopardy. Thus expeditious research is required on the relationship of C. hubbsi and C. variegatus.

The subspecies Cyprinodon variegatus variegatus is known to occur along the entire coast of Florida, at times penetrating into fresh waters. Large populations of C. v. variegatus are present in the brackish water impoundments of Merritt Island and these serve as representative examples of Cyprinodon from the east coast of Florida with which other populations of C. variegatus and C. hubbsi will be compared. A second subspecies, C. v. riverendi from Cuba, possibly exists in the Florida Keys. Within the range of C. variegatus in Florida, wide morphological variations have been noted, and the presence of other well-defined taxonomic units has been postulated. This study will attempt to define the morphological variation and systematic relationship of C. variegatus and C. hubbsi in Florida. Special attention is being directed toward observing the ecological nitch inhabited by Cyprinodon from Merritt Island and other estuarine hab-

itats so that comparisons might be made with fresh water populations and species. The ecological parameters which affect the distribution of these fish and isolate them into distinct populations are poorly understood.

The following list of titles represents reports or studies carried out by undergraduate students affiliated with this grant.

A Summer Bird Census of the Merritt Island National Wildlife Refuge. Mr. Ned Steel, 20 pages.

History, Distribution, Habitat and Notes concerning the current status of the dusky seaside sparrow, Ammospiza nigrescens. Ms. Patricia G. Dolan, 16 pages.

Lynx rufus: an independent study. Mr. George Tanner, 11 pages.

Birds of North Merritt Island. Mr. Ned Steel, 43 pages.

Observations on the Size and Interval of Successive broods in Poecilia latipinna (LeSueur) Poeciliidae, Mr. Wallace W. Gee, 20 pages.

APPENDIX A

TABLES AND FIGURES

Table 1. Communities of Merritt Island and Their Conspicuous Plant Components.

I. Areas dominated by grasses:

A. Xeric areas

1. Fresh

a. RUDERAL GRASS; bahia (Paspalum notatum)

2. Saline:

a. COASTAL GRASS: sea oats (Uniola paniculata), saw palmetto (Serenoa repens) sea grape (Coccoloba uvifera), Scaveola plumieri

B. Hydric areas

1. Fresh

a. SPARTINA MARSH: bunch grass (Spartina bakerii), saw grass (Cladium jamaicensis), Sagittaria spp.,cat tail (Typha latifolia), rush (Scirpus validus), arrowhead (Sagittaria latifolia)

b. GRASS SWALES: grasses (Andropogan, Spartina, Aristida), red root (Lachnanthes caroliniana), sundews (Drosera spp.), & herbs

2. Saline:

a. SPARTINA SALT MARSH: Bunch grass (Spartina bakerii), Leather fern (Acrostichum), black rush (Juncus), cat tail (Typha domingensis), occasional Sabal palmetto

b. DISTICHILIS MARSH: salt grass (Distichilis spicata), Paspalum vaginatum, cat tail (Typha domingensis), occasional black mangrove (Avicennia germinans)

II. Areas dominated by flatwoods to high shrubs (flatwoods are an association of plants which are all about the same height within a 2 to 10 foot range. Occasional trees may be present.)

A. Xeric areas

1. Fresh:

a. SCRUBBY FLATWOODS: saw palmetto (Seronoa repens), Lyonia (L. fruiticosa, L. lucida, L. ferruginea), Oaks (Quercus myrtifolia, Q. chapmanii, Q. pumilla), wire grass (Aristida stricta), huckleberry (Gaylussacia), tarflower (Befaria racemosa)

b. PINE FLATWOODS: saw palmetto (Seronoa repens), Lyonia (L. fruiticosa, L. lucida), oaks (Quercus pumilla, Q. geminata), wire grass (Aristida stricta), dwarf wax myrtle (Myrica pusilla) occasional pine (Pinus elliottii)

2. saline:

a. OAK COASTAL FLATWOODS: saw palmetto (Seronoa repens), wax myrtle (Myrica cerifera), live oak (Quercus virginiana), stopper wood (Eugenia Spp.). and red bay (Persea borbonia)

b. DIKE COMMUNITIES (ruderal)

B. Mesic areas

1. Fresh

a. POND MARGIN: Saw palmetto (Seronoa repens), gallberry (Ilex glabra), Lyonia lucida, wax myrtle (Myrica cerifera)

2. Saline:

a. SALT MARGIN: Saw palmetto (Seronoa repens), groundsel (Baccharis glomeruliflora), juniper (Juniperus silicicola), wax myrtle (Myrica cerifera), bunch grass (Spartina bakerii)

b. HOLLY COASTAL FLATWOODS: Holly (Ilex vomitoria), saw palmetto (Seronoa repens), spanish bayonet (Yucca aloifolia), oak (Quercus virginiana), groundsel (Baccharis glomerulifolia), cabbage palm (Sabal palmetto), juniper (Juniperus siliciola), Sea oxeye (Borrichia arborescens),

III. Areas dominated by high shrubs to trees

A. Xeric areas

1. Fresh:

a. PINE FLATWOODS; Slash pine (Pinus elliottii), underbrush same as PINE FLATWOODS above

B. Mesic areas

1. Fresh

a. Palm-Oak-Wax Myrtle: cabbage palm (Sabal palmetto), wax myrtle (Myrica cerifera), oak (Quercus virginiana), saw palmetto (Seronoa repens)

Table 1. Continued.

b. SWEETGUM ASSOCIATION: Sweet-gum (Liquidambar styraciflua), Wax myrtle (Myrica cerifera), cinnamon fern (Osmunda cinnamomea), saw palmetto (Seronoa repens)

c. PLANTED AREAS:

1. citrus

2. Australian pine (Casuarina)

3. Foundations: Camphor (Cinnamomum camphora), Eucalyptus, Brazilian pepper (Schinus terebinthifolius), bamboo

d. HARDWOOD HAMMOCK: live oak (Quercus virginiana), marlberry (Ardisia escallonioides), lancewood (Nectandria coriacea), cabbage palm (Sabal palmetto), Myrsine quianensis, bay (Persea borbonia, P. palustris), mulberry (Morus rubra), wild coffee (Psychotria Spp.) hackberry (Celtis laevigata)

e. PALM HAMMOCK: cabbage palm (Sabal palmetto), ferns

C. Hydric areas

1. Fresh:

a. HYDRIC HAMMOCK: Cabbage palm (Sabal palmetto), elm (Ulmus floridana), holly (Ilex cassine), red maple (acer rubrum), laurel oak (Quercus laurifolia), Leather fern (Acrostichum)

b. POND PINE ASSOCIATION: pond pine (Pinus serrotina)

c. WILLOW ASSOCIATION: willow (Salix caroliniana) mixed with plants of the SPARTINA MARSH

d. MAPLE ASSOCIATION: red maple (Acer rubrum)

e. PERSIMMON POND MARGIN: Persimmon (Diospyros virginiana)

2. Saline

a. PALM SAVANNA: cabbage palm (Sabal palmetto) mixed with plants of the SPARTINA MARSH.

b. BLACK MANGROVE ASSOCIATION: Black mangrove (Avicennia geminans)

c. WHITE MANGROVE ASSOCIATION: White mangrove (Laguncularia racemosa)

IV. Ponds dominated by floating and submerged vegetation

Table 2. The Percent Cover and Frequency of Occurrence of Plant Species Found in Four Different Plant Communities

	% COVER / % FREQUENCY			
	Flatwoods		Coastal	
	SCRUBBY	PINE	COASTAL	STRAND
Serenoa Repens (Saw Palmetto)	45/70	25/48	63/75	41/50
Lyonia Lucida (Fetterbush)	2/17	30/95		
L. Fruiticosa (Staggerbush)	1/20	.4/15		
L. Ferruginea (Rusty Lyonia)	.1/25			
Quercus Pumilla (Running Oak)	4/30	12/65		
Q. Myrtifolia (Myrtle Oak)	51/82	2/2		
Q. Chapmanii (Chapman Oak)	7/25	1/5		
Q. Virginiana (Live Oak)			37/50	*
Var, Geminata (Sand Live Oak)		4/7		
Myrica Pusilla (Dwarf Wax Myrtle)	1/2	4/27		
Myrica Cerifera (Wax Myrtle)			10/27	1/7
Befaria Racemosa (Tar Flower)	1/5	2/10		
Eugenia Sp. 1 (Stopper Wood)			21/37	*
Eugenia Sp. 2 (Stopper Wood)			7/20	
Licania Michauxii (Gopher Apple)	1/7		1/12	
Gaylussacia Sp. (Huckleberry)	4/45	1/30		
Ceratiola Sp. (Rosemary)		4/35		
Ilex Glabra (Gallberry)		2/7		
Vaccinium Sp. (Blueberry)	1/20	.6/22		
Ground Moss	2/27	1/5		
Ground Lichen	1/17	4/15		
Smilax Sp. (Green Briars)	1/2		*	1/12
Bumelia Sp. (Buckthorn)			*	1/2
Senecio Sp. (Ragwort)				6/35
Coccoloba Uvifera (Sea Grape)				6/10
Yucca Aloifolia (Spanish Bayonet)	*			*
Aristida (Wire Grass)	14/50	50/97		
Panicum (Grass)	.1/2	1/17		
Andropogon (Grass)		.1/5		1/10
Uniola Paniculata (Sea Oats)				8/22
Additional Unique Species:				
Number	6	3	10	20
Cumulative Cover/Frequency	.5/10	1/12	.8/5	5.5/50

*Observed But Not Encountered

Table 3. The Percent Cover and Percent Frequency of Occurrence of Plant Species.

PALM-OAK-WAX MYRTLE

	% COVER/% FREQUENCY
SERENOA REPENS (SAW PALMETTO)	68/82
QUERCUS VIRGINIANA VAR.VIRGINIANA (LIVE OAK)	23/40
SABAL PALMETTO (CABBAGE PALM)	15/22
MYRICA CERIFERA (WAX MYRTLE)	14/22
OSMUNDA CINNAMOMEA (CINNAMON FERN)	9/15
FIMBRISTYLIS SP.. (RUSH-LIKE)	7/15
WOODWARDIA VIRGINICA (VIRGINIA CHAIN FERN)	6/20
BACCARIS HALIMIFOLIA VAR. ANGUSTIOR (GROUNDSEL)	4/10
GALACIA ELLIOTTII (MILK PEA)	4/30
VITIS ROTUNDIFOLIA (MUSCADINE GRAPE)	2/17
PTERIDIUM AQUILINUM (BRACKEN FERN)	2/10
DIOSPYROS VIRGINIANA (PERSIMMON)	1.6/ 2
BLECHNUM SERRULATUM (BLECHNUM FERN)	0.9/ 2
ERYTHRINA HERBACEA (CORAL BEAN)	0.9/ 2
ANDROPOGON VIRGINICUS (BROOM SEDGE)	0.7/ 5
LYONIA LUCIDA (FETTERBUSH)	0.4/ 2
SMILAX AURICULATA (GREENBRIERS)	0.4/ 5
APIOS AMERICANA (POTATO BEAN)	0.4/ 2
PANICUM SP. (PANIC GRASS)	0.4/15
UNIDENTIFIED (SEEDLING)	0.2/ 8
RHUS RADICANS (POISON IVY)	0.2/ 8
UNIDENTIFIED (SEDGE)	0.1/ 5
PLUCHEA ROSEA (MARSH FLEABANE)	0.1/ 5
MIKANA SCANDENS (CLIMBING HEMPWEED)	0.1/ 5
PHRAGMITES AUSTRALIS	0.06/ 2
IPOMEA SAGITTATA (MORNING GLORY)	0.06/ 2
HYDROCOTYLE UMBELLATA (MARSH PENNYWORT)	0.06/ 2
UNIDENTIFIED (LEGUME)	0.06/ 2
TRICHOSTEMA DICHOTOMUM (BLUE CURL)	0.06/ 2
DIVERSITY INDEX (BRILLOUIN)	3.670

Table 4. The Percent Cover and Frequency of Occurrence of Plant Species.

Palm Savanna

	% Cover/% Frequency
Spartina bakerii (Cordgrass)	56/87
Juncus roemerianus (Black rush)	15/25
Unidentified (Sedge 1)	5 /14
Sagittaria latifolia (Arrowhead, Wapato)	3.5/12
Sabal palmetto (Cabbage palm)	3.4/ 4
Kosteletzkya althaeifolia (fen rose, mallow)	1.8/ 4
Acrostichum danaeaefolium (leather fern)	1.7/ 8
Bacopa monnieri (Water hyssop)	1.6/12
Blechnum serrulatum (Blechnum fern)	1.1/ 4
Ipomea sagittata (Morning glory)	0.6/14
Lachnanthes caroliniana (Redroot)	0.4/14
Borrichia frutescens (Sea oxeye)	0.3/ 2
Unidentified (Grass)	0.2/ 8
Unidentified (seedling 1)	0.2/ 8
Pluchea rosea (Marsh fleabane)	0.15/ 6
Unidentified (seedling 2)	0.15/ 6
Eupatorium sp. (Dog fennel)	0.1/ 4
Amaranthus cannabinus (Pigweed)	0.1/ 4
Solanum americanum (Nightshade)	0.05/ 2
Mikana scandens (Climbing hempweed)	0.05/ 2
Unidentified (Rush)	0.05/ 2
Solidago sp. (Goldenrod)	0.05/ 2
Ludwigia repens	0.05/ 2
Unidentified (Composite)	0.05/ 2
Unidentified (Sedge 2)	0.05/ 2
Diversity Index (Brillouin)	3.274

Table 5: The Percent Cover and Percent Frequency of Occurrence of Plant Species.

Spartina Marsh

	% Cover/% Frequency for Each Phase:				
	SHALLOW	INTER-MEDIATE	DEEP SPARTINA	SAW GRASS	TOTAL MARSH
Spartina Bakerii (Cordgrass)	49/80	66/100	87/100	21/50	56/82
Ludwigia Repens	20/70	37/100	27/95	43/95	32/90
Kosteletzkya Althaeifolia (Fen Rose, Mallow)	10/75	0.5/20			2.6/24
Fimbristylis SP, (Rush-Like)	7.4/30				1.8/7
Polygonium Persicaria (Heartweed)	4.4/50	2.4/70	0.25/10	0.12/5	1.8/34
Hydrocotyle Umbellata (Marsh Pennywort)	3.6/45				1.0/11
Mikania Scandens (Climbing Hempweed)	3.1/50	4.5/55	2.2/40	1.6/40	2.8/46
Bacopa Monnieri (Water Hyssop)	3.0/20	0.12/5			0.8/6
Dichromena Latifolia (Sedge)	2.1/15				0.5/4
Phragmites Australis	2.0/30				0.5/8
Unidentified (Sedge)	2.0/10				0.5/2
Cladium Jamaicensis (Saw Grass)	2.0/10			52/100	13/27
Sagittaria Latifolia (Arrowhead, Wapato)	1.9/5	6.9/55	1.7/20	7.9/50	5/32
Hymenocallis Palmeri (Spider Lily)	1.6/15				0.4/4
Hyptis Alata (Mint)	1.5/35	0.12/5			0.4/10
Ludwigia Palustris (Water-Purslane)	1.25/25	1.4/30	0.9/10	0.25/10	0.6/19
Ipomea Sagittata (Morning Glory)	1.2/50	2.2/65	2.7/35	0.75/30	1.7/45

Table 5. Continued

Spartina Marsh-Continued

	% Cover/% Frequency for Each Phase:				
	SHALLOW	INTER-MEDIATE	DEEP SPARTINA	SAW GRASS	TOTAL MARSH
Diospyros Virginiana (Persimmon)	0.75/5				0.2/1
Unidentified (Grass)	0.75/5				0.2/1
Solidago SP. (Goldenrod)	0.5/20				0.1/5
Linaria Floridana (Toad Flax)	0.37/15				0.1/4
Rotala Ramosior (Tooth Cup)	0.25/10				0.6/2
Pluchea Rosea (Marsh Fleabane)	0.25/10				0.6/2
Vicia Acutifolia (Vetch)	0.25/10				0.6/2
Lippia Nodiflora (Capeweed)	0.25/10				0.6/2
Galium Pilosum Var, Laevicaule (Bedstraw)	0.25/10				0.6/2
Centella Asiatica (Coin Wort)	0.25/10				0.6/2
Sambucus Simpsonii (Elderberry)	0.12/5				0.3/1
Cirsium Horridulum (Purple Thistle)	0.12/5				0.3/1
Typha Latifolia (Cattail)	0.12/5				0.3/1
Baccharis Halimifolia Var, Angustior (Groundsel)	0.12/5				0.3/1
Unidentified (Seedling)	0.12/5				0.3/1
Utricularia Inflata Var, Minor (Bladderwort)		0.37/15		0.5/20	0.4/9
Sagittaria Stagnorum		0.12/5	9.1/30	12.7/35	5/17
Unidentified (Green Algae)		0.75/5		0.9/10	0.4/4

Table 5. Continued

Spartina Marsh -Continued

	% Cover/% Frequency for Each Phase:				
	SHALLOW	INTER-MEDIATE	DEEP SPARTINA	SAW GRASS	TOTAL MARSH
Salix Caroliniana (Willow)				+	+
Ceratophyllum Demersum (Coontail)			+	+	+
Acer Rubrum (Red Maple)	+				+
Vitis Labrusca (Fox Grape)	+				+
Coreopsis Leavenworthii (Tickseed)	+				+
Panicum SP. (Panic Grass)	+				+
Riccia SP. (Liverwort)				+	+
Diversity Index (Brillouin)	4.012	2.894	2.428	2.821	3.857

Table 6. The Percent Cover and Percent Frequency of Occurrence of Plant Species.

Australian Pine

	% Cover/% Frequency
Casuarina glauca (Australian Pine)	97/100
Sabal palmetto (Cabbage Palm)	2.2/15
Rubus trivialis (Rasberry)	1.2/10
Pteridium aquilinum (Bracken fern)	0.1/ 5
Smilax auriculata (Green briers)	0.5/ 7
Parthenocissus quinquefolia (Virginia creeper)	+
Diversity Index (Brillouin)	1.200

Table 7. Diversity Index of Different Merritt Island Plant Communities

Community Type	Brillouin Diversity Index	Number of Species
Pine Flatwood	3.317	23
Scrubby Flatwoods	3.357	21
Coastal Flatwoods	2.134	17
Coastal Grass	3.324	32
Spartina Marsh	3.857	43
Shallow Phase	4.012	36
Intermediate Phase	2.894	14
Deep Phase	2.428	10
Saw Grass Phase	2.857	14
Palm Savanna	3.274	25
Palm-Oak-Wax Myrtle	3.670	29
Australian Pine	1.200	6

Table 8. The Percentage of The Vegetation Map (Figure 3) Which is Covered By Each Plant Community

FLATWOODS	
PINE	43%
SCRUBBY	3
SALT MARGIN	1
OAK COASTAL	<1
POND MARGIN	<1
HAMMOCKS	
HARDWOOD & HYDRIC	3
WILLOW	1
MAPLE	<1
PALM-OAK-WAX MYRTLE	16
PALM SAVANNA	5
PRAIRIES & MARSHES	
SPARTINA SALT	9
DISTICHILIS	5
SPARTINA	2
GRASS SWALES	1
MANGROVE	2
RUDERAL	3
OPEN WATER	5

Table 9. Floristic Survey Status as of July 12, 1973

SPECIES COLLECTED AND IDENTIFIED	425
SPECIES COLLECTED BUT NOT YET IDENTIFIED	80
SPECIES IDENTIFIED BUT NOT YET COLLECTED	32
NUMBER OF SPECIES KNOWN TO BE ON THE ISLAND	537
NUMBER OF GENERA IDENTIFIED	313
NUMBER OF EXOTICS (ESCAPED, NATURALIZED OR PLANTED)	127

Table 10. Plants Absent or Occurring in Below Anticipated Levels

	EXPECTED LOCATION	ESTIMATED % EXPECTED OCCURRANCE *
Trees:		
Pinus Palustris: Long Leaf Pine	Flatwoods	1%
Pinus Clausa: Sand Pine	Flatwoods	5%
Pinus Elliottii: Slash Pine	Flatwoods	15%
Liquidambar Styraciflua: Sweet Gum	Hammocks	1% **
Magnolia Grandiflora: Bull Bay	Hammocks	0% **
Magnolia Virginiana: Sweet Bay	Hammocks	5%
Gordonia Lasianthus: Loglolly Bay	Hammocks	0%
Taxodium Distichum: Bald Cypress	Hammocks	0%
Taxodium Ascendens: Pond Cypress	Hammocks	0% **
Nyssa Sylvatica: Blackgum	Hammocks	0%
Herbacious Plants:		
Encyclia Tampensis: Orchid	Hammocks	5%
Malaxis Spicata: Orchid	Hammocks	5%
Thalia Sp.: Fireflag	Marsh/Ponds	5% **
Nymphaea Sp.: Waterlily	Ditch/Ponds	5%
Piaropus Crassipes: Water Hyacinth	Ditch/Ponds	10%
Psilotum Nudum: Whisk Fern	Palm Stands	5%
Lycopodium Sp.: Club Moss	Hammocks	0%
Plants Present But Not Anticipated:		
Dodonaea Viscosa: Varnish Leaf (Shrub)		
Tripsacum Floridana: Gama Grass		

*100% Would Equal The Frequency With Which Each Species Would Be Anticipated To Occur On The Island.

**Those Observed May Be Planted

Table 11. The Reproductive Status of Happy Hammock

HAPPY HAMMOCK: TREE SIZE

	(Number Of Trees Encountered As:)				
	Seedlings <1M	Saplings	Young Trees >1M Tall	Trees	Mature Trees
Species	0-2"	0-2"	2-4"	4-8"	8+"
Persea Borbonia (Red Bay)	9				
Quercus Virginiana (Live Oak)					1
Myrica Cerifera (Waxmyrtle)		1			
Morus Rubra (Mulberry)		1	4		
Celtis Laevigata (Hackberry)	1				
Eugenia Sp. (Stopperwood)	1				
Ardisia Escallonioides (Marlberry)	69	4		2	
Nectandria Coriacea (Lancewood)	189	16	2		
Rapanea Guianensis	118	27	2		
Persea Palustris (Swamp Bay)	2	2			
Ulmus Sp. (Elm)		1	1		
Quercus Laurifolia (Laurel Oak)	3	1			
Acer Rabrum (Red Maple)	9				
Sabal Palmetto (Cabbage Palm)		34 (Seedlings)	4 (Up to 2M Tall)	9 (Taller Than 2M)	

Table 12. Mammal Study Summary

TRAP TYPE	TRAP NIGHTS	TOTAL INDIVIDUALS	TOTAL CAPTURES
SHERMAN			
SMALL MAMMAL (3" x 3" x 9" AND 2" x 2 1/2" x 7")	20,736	340	1,212 (5.8%)
LARGE MAMMAL (10" x 12" x 32" AND 9" x 9" x 26")			
ISLAND INTERIOR	2,880	144	231 (8.0%)
COASTAL STRAND	3,500	211	549 (15.7%)
GRAND TOTALS	27,116	695	1,992 (7.3%)

Table 13. Preliminary Study of Neofiber Allen 1

TRAP NIGHTS: 1000
INDIVIDUALS CAPTURED: 13
RECAPTURES: 5
TOTAL CAPTURES: 18
WEIGHT $\bar{X}$ (MALES): 346.4 ± 12.8 G.
WEIGHT $\bar{X}$ (FEMALES): 319.2 ± 29.8 G.
LARGEST MALE: 383.6 G.
LARGEST FEMALE: 349.2 G.

Table 14. Large Mammals of Interior and Impoundments

	Procyon	Didelphis	Spilogale
Total No.:	38	52	22
Sex Ratio: (M:F):	19:14	11:22	-
Wt. $\bar{x}$ Ad. males: (g)	5153	1896	381
Wt. $\bar{x}$ Ad. females: (g)	4517	1586	
t =	1.94 Ns	1.81 Ns	-
Hind Ft. $\bar{x}$ Ad. males: (mm)	122	65	39
Hind Ft. $\bar{x}$ Ad. females: (mm)	115	61	
t =	1.62 Ns	1.98 Ns	-
Largest male (g):	6950	2600	500
Largest female (g):	6550	2010	
No. Recaptures	7	30	15
Total Captures:	45	82	37

Table 15. Large Mammals of The Coastal Strand

	Procyon	Didelphis	Spilogale	S. floridanus	S. palustris
TOTAL NO.:	35	14	90	43	12
SEX RATION: (M:F)	22 : 13	9 : 5	61 : 29	21 : 22	12 : 0
WT. $\bar{X}$ AD. MALES: (G)	4988	1874	422	942	1091
WT. $\bar{X}$ AD. FEMALES: (G)	4426	1832	275	1034	------
T =	1.92 ns	0.03 ns	7.04*	2.93*	------
HIND FT. $\bar{X}$ AD. MALES: (MM)	118	65	40	87	76
HIND FT. $\bar{X}$ AD. FEMALES: (MM)	114	61	36	87	------
T=	2.36 ns	1.38 ns	5.48*	0.39 ns	------
LARGEST MALE (G):	6340	22.70	620	1140	1250
LARGEST FEMALE (G):	5990	1840	340	1180	------
NO. MALE RECAPTURES	4	18	218	30	0
NO. FEMALE RECAPTURES	3	13	38	15	------
TOTAL CAPTURES:	42	45	346	84	12

Table 16. Annotated List of Amphibian And Reptile Species Discovered On Merritt Island

AMPHIBIA

Family Bufonidae

Bufo terrestris - southern toad: common in many habitats.

Bufo quercicus - oak toad: common in the flatwoods.

Family Leptodactylidae

Eleutherodactylus ricordi - greenhouse frog: the species name planirostris is currently used by some authors; common in the hammocks.

Family Hylidae

Hyla femoralis - pine woods treefrog: common in the flatwoods; several collections made.

Hyla cinerea - green treefrog: the most common climbing treefrog of marshes and wetlands; collected systematically in our marsh study area.

Hyla gratiosa - barking treefrog: apparently rare, only a single individual collected.

Hyla squirella - squirrel treefrog: less common on Merritt Island than on adjacent mainland areas of central Florida; several collections made.

Hyla ocularis - little grass frog: the genus name Limnoaedus is currently used by some authors; abundant in the flatwoods but inconspicuous when not breeding; several collections made.

Acris gryllus - southern cricket frog: abundant in all wetlands; several collections made.

Table 16. Continued

Family Microhylidae

Gastrophryne carolinensis - eastern narrow-mouthed toad: positively identified on the basis of its call; not collected as yet.

Family Ranidae

Rana pipiens - leopard frog: abundant in all wetland areas; several collections.

Rana grylio - pig frog: common in deep water marshes and impoundments; several collections.

REPTILIA

Family Chelydridae

Chelydra serpentina - snapping turtle: the species name osceola is currently used by some authors for Florida populations; common in fresh water habitats.

Family Kinosternidae

Kinosternon bauri - striped mud turtle: common in a variety of fresh water habitats.

Kinosternon subrubrum - mud turtle: common in a variety of fresh water habitats.

Family Testudinidae

Deirochelys reticularia - chicken turtle: the most common aquatic turtle on Merritt Island; found in all fresh water habitats.

Malaclemys terrapin - diamondback terrapin: a substantial population of this uncommon turtle is present in the brackish waters surrounding Merritt Island; they are inconspicuous except when they come ashore to lay eggs.

Pseudemys floridana - cooter: the genus name Chrysemys is currently used by some authors; common in most fresh water situations.

Terrapene carolina - box turtle: a common terrestrial turtle found in most habitats; many marked and released.

Gopherus polyphemus - gopher tortoise: a common terrestrial turtle common in scrub and flatwoods habitats; many marked and released.

Table 16. Continued

Family Cheloniidae

Caretta caretta - loggerhead turtle: a marine turtle that nests commonly on the beaches of Merritt Island during summer months; under intensive study.

Chelonia mydas - green turtle: a marine turtle that nests rarely on the beaches of Merritt Island during summer months; one individual marked and released.

Family Trionychidae

Trionyx ferox - Florida soft shell turtle: a highly aquatic turtle of fresh and mildly brackish habitats; probably very common but not regularly encountered without specialized collecting techniques.

Family Iguanidae

Anolis carolinensis - green anole: common in a variety of habitats.

Family Anguidae

Ophisaurus ventralis - eastern glass lizard: occasional in the flatwoods.

Family Teiidae

Cnemidophorus sexlineatus - six-lined racerunner: common in scrub and flatwoods habitats.

Family Scincidae

Eumeces egregius - mole skink; one specimen observed but not captured.

Eumeces inexpectatus - southeastern five-line skink: occasional in a variety of habitats.

Lygosoma laterale - ground skink: the genus name Scincella is currently used by some authors; occasional in hammocks and flatwood.

Family Colubridae

Cemophora coccinea - scarlet snake: uncommon.

Coluber constrictor - black racer: abundant, encountered in all habitats.

Diadophis punctatus - eastern ringneck snake: rare, only one specimen collected.

Drymarchon corais - indigo snake: a snake protected by Florida law; several specimens collected.

Elaphe guttata - corn snake: common.

Elaphe obsoleta - rat snake: common.

Farancia abacura - mud snake: a large aquatic species occasionally encountered around wetlands.

Lampropeltis getulus - common kingsnake: common, especially in more hydric areas.

Liodytes alleni - striped swamp snake: the genus name Regina is currently used by some authors; rare, only two specimens collected.

Masticophis flagellum - coachwhip: uncommon.

Natrix cyclopion - green water snake: common.

Natrix fasciata - banded water snake: common around both fresh and brackish water habitats; one specimen resembling the rare subspecies taeniata (Atlantic salt marsh snake) has been discovered.

Opheodrys aestivus - rough green snake: common.

Pituophis melanoleucas - pine snake: rare, only one specimen collected.

Storeria dekayi - brown snake: rare, only one specimen collected.

Thamnophis sauritus - ribbon snake: very common in a variety of habitats.

Thamnophis sirtalis - common garter snake: very common in a variety of habitats.

Family Crotalidae

Agkistrodon piscivorus - cottonmouth: very common in most fresh water situations.

Crotalus adamanteus - eastern diamondback rattlesnake: very common in scrub and flatwoods habitats.

Sistrurus miliarius - pigmy rattlesnake: common in a variety of habitats.

Table 16. Continued

Family Crocodilidae

Alligator mississippiensis - American alligator: common in most large bodies of water with sufficient depth and cover.

Table 17. Preliminary Results of Marine Turtle Studies

NIGHTS IN FIELD:	15
TOTAL TURTLES (*CARETTA*):	39
NO. RECAPTURES:	2
WEIGHT $\bar{x}$ (S.E.)	268.4 (7.6) LBS.
CARAPACE LENGTH:	39.4 (0.3) IN.
CARAPACE WIDTH:	36.2 (0.3) IN.
PLASTRON LENGTH:	28.4 (0.3) IN.
LARGEST:	385 LBS.

Table 18. Annotated List of Fish Species Found In The Fresh And Impounded Brackish Waters of Merritt Island

Family Lepisosteidae

Lepisosteus platyrhincus - Florida gar: common in most permanent ditches, ponds, and impoundments; absent at higher salinities.

Family Elopidae

Elops saurus - ladyfish: an estuarine species that enters our study areas only rarely.

Family Engraulidae

Anchoa mitchilli - bay anchovy: an estuarine species that enters our study areas only rarely.

Family Cyprinidae

Notemigonus crysoleucas - golden shiner: a schooling minnow common in some fresh water ditches and ponds; probably present on the Island as a result of bait release.

Family Catostomidae

Erimyzon sucetta - lake chubsucker: uncommon in some roadside ditches and ponds.

Family Ictaluridae

Ictalurus natalis - yellow bullhead: a single specimen of this catfish has been collected; its distribution and abundance on Merritt Island need additional study.

Family Ariidae

Arius felis - sea catfish: an estuarine species that enters our study areas only rarely.

Family Belonidae

Strongylura notata - redfin needlefish: uncommon in brackish ditches and impoundments.

Family Cyprinodontidae

Cyprinodon variegatus - sheepshead minnow: common in most brackish water impoundments; under intensive study.

Fundulus chrysotus - golden topminnow: common in heavily vegetated fresh water ditches and ponds.

Fundulus confluentus - marsh killifish: occasional in a variety of ecological situations.

Fundulus grandis - Gulf killifish: common in most brackish waters.

Fundulus seminolis - Seminole killifish: occasional in a variety of ecological situations.

Jordanella floridae - flagfish: uncommon, but usually present in small numbers in heavily vegetated fresh water ditches and ponds.

Lucania goodei - bluefin killifish: very common in most freshwater situations.

Lucania parva - rainwater killifish: common to abundant in brackish ditches and impoundments.

Family Poeciliidae

Gambusia affinis - mosquitofish: the most abundant fish on Merritt Island; found in all habitats.

Heterandria formosa - least killifish: common in most vegetated fresh water habitats.

Poecilia latipinna - sailfin molly: only slightly less abundant than the mosquitofish and equally ubiquitous; under intensive study.

Family Atherinidae

Menidia beryllina - tidewater silversides: a schooling species common in deeper, more open parts of brackish ditches and impoundments.

Family Syngnathidae

Syngnathus scovelli - Gulf pipefish: an estuarine species that enters our study areas only rarely.

Family Centrarchidae

Lepomis gulosus - warmouth: common in fresh water ditches and ponds.

Lepomis macrochirus - bluegill: common in fresh water ditches, ponds, and impoundments; stocked on the Island at one time.

Lepomis marginatus - dollar sunfish: uncommon in heavily vegetated freshwater ditches.

Lepomis microlophus - redear sunfish: uncommon in freshwater ditches, ponds, and impoundments; probably stocked with the bluegill.

Lepomis punctatus - spotted sunfish: rare in a variety of fresh water habitats.

Micropterus salmoides - largemouth bass: common in certain fresh water ditches, ponds, and impoundments; stocked on the island at one time.

Family Mugilidae

Mugil cephalus - striped mullet: uncommon in some brackish water ditches and impoundments.

Mugil curema - white mullet: rare in open brackish water ditches; juveniles of both mullet species penetrate accessible brackish water areas of Merritt Island and pass through their early development in these nursery areas.

Family Gobiidae

Gobiosoma bosci - naked goby: rare in some brackish water impoundments.

Microgobius gulosus - clown goby: rare in some brackish water ditches and impoundments.

Table 19. Changes In Relative Abundance of Some Fishes In The VAB Pond. Figures Are Number of Fish Caught Per Minute

	1972			1973					
	Summer	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
C. variegatus	18	135	22	80	18	42	40	99	16
F. confluentus	-	-	-	-	-	-	<1	<1	4
F. grandis	<1	-	<1	<1	-	-	<1	4	<1
L. parva	5	6	21	18	16	8	5	175	48
M. beryllina	4	28	46	6	6	2	<1	29	15
G. affinis	35	106	43	116	89	126	287	527	115
P. latipinna	109	386	242	106	154	55	134	664	201

Table 20. Changes In Relative Abundance of Some Fishes In Impoundment T - 24 - B. Figures Are Number of Fish Caught Per Minute

	1972			1973				
	Summer	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
C. variegatus	17	19	9	<1	2	25	27	6	33
L. parva	235	40	33	7	7	39	21	33	162
F. grandis	3	-	-	-	-	<1	-	<1	1
M. beryllina	28	12	1	<1	<1	5	1	<1	6
G. affinis	5	<1	13	1	<1	4	1	3	13
P. latipinna	3	<1	4	3	1	13	1	4	6

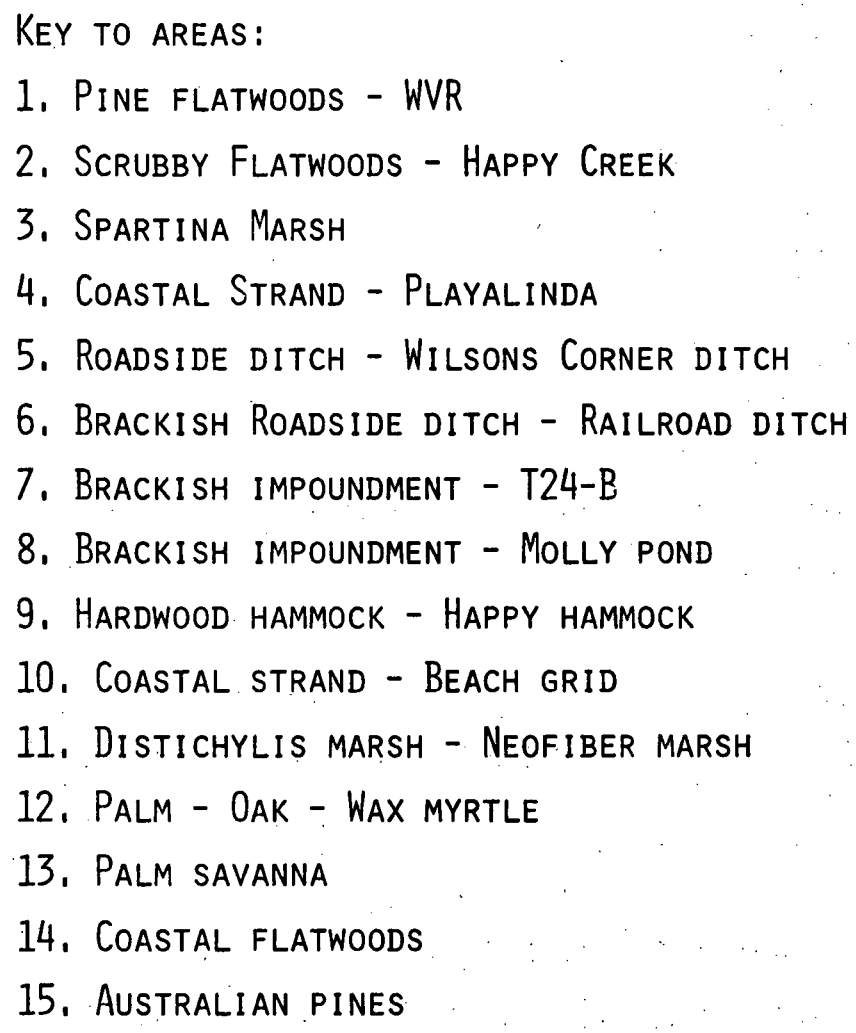
Table 21. Changes In Relative Abundance of Some Fishes In Wilson's Corner Ditch. Figures Are Number of Fish Caught Per Minute.

	1972			1973					
	Summer	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
N. crysoleucas	<1	3	<1	-	-	-	3	2	19
E. sucetta	-	-	-	5	2	11	12	-	11
F. chrysotus	53	43	21	32	12	14	47	117	101
J. floridae	<1	8	<1	1	-	-	11	18	1
L. goodei	158	11	39	130	86	131	92	84	165
G. affinis	431	342	80	274	63	286	515	550	148
H. formosa	26	2	4	8	15	20	197	121	12
P. latipinna	37	73	17	15	2	21	2	166	3
L. gulosus	11	2	3	10	2	5	20	12	19
L. macrochirus	16	<1	-	6	2	6	8	28	13
M. salmoides	<1	-	-	-	-	-	32	28	30

Table 22. Reproductive Structure of The VAB of Poecilia Latipinna For Nine Months

	1972			1973					
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
SEX RATIO									
All Specimens (M:F)	40:60	31:69	49:51	44:56	50:50	46:54	36:64	51:49	32:68
Adult Specimens (M:F)	42:58	34:66	64:36	47:53	59:41	53:47	39:61	56:44	36:64
ADULT MALES									
% Mature	48	52	49	58	38	26	60	83	78
% of All Specimens	39	30	44	42	47	42	36	51	32
ADULT FEMALES									
% Gravid	<1	0	0	0	0	0	18	61	20
% of All Specimens	53	59	25	49	33	37	57	40	58
N	403	887	697	317	396	202	672	1427	900

Figure 1. A Generalized Map of Northern Merritt Island Locating The Major Study Areas


KEY TO AREAS:
1. PINE FLATWOODS - WVR
2. SCRUBBY FLATWOODS - HAPPY CREEK
3. SPARTINA MARSH
4. COASTAL STRAND - PLAYALINDA
5. ROADSIDE DITCH - WILSONS CORNER DITCH
6. BRACKISH ROADSIDE DITCH - RAILROAD DITCH
7. BRACKISH IMPOUNDMENT - T24-B
8. BRACKISH IMPOUNDMENT - MOLLY POND
9. HARDWOOD HAMMOCK - HAPPY HAMMOCK
10. COASTAL STRAND - BEACH GRID
11. DISTICHYLIS MARSH - NEOFIBER MARSH
12. PALM - OAK - WAX MYRTLE
13. PALM SAVANNA
14. COASTAL FLATWOODS
15. AUSTRALIAN PINES

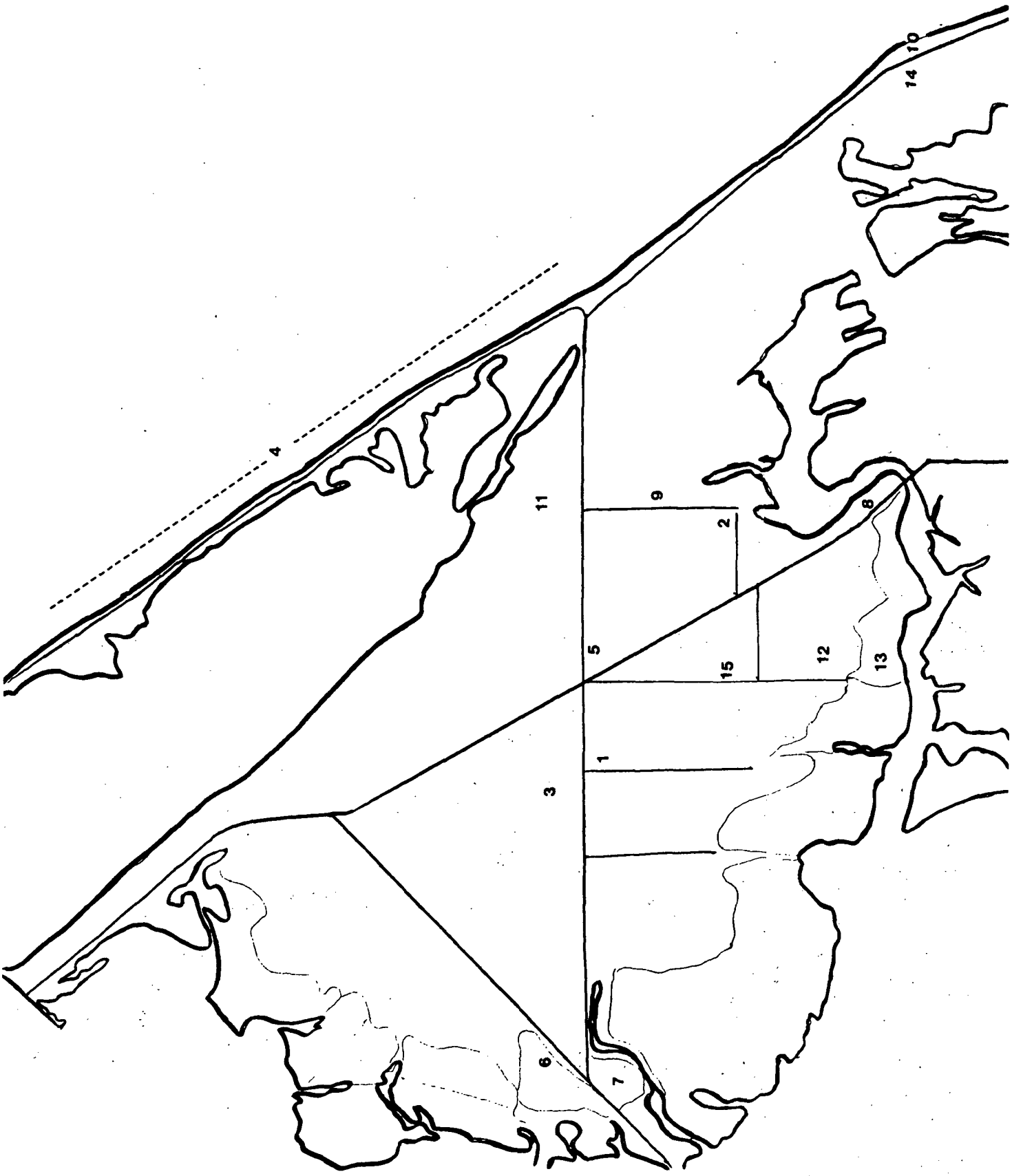


Figure 1

DEPTH RANGE OF VEGETATION TYPES IN A SPARTINA MARSH.

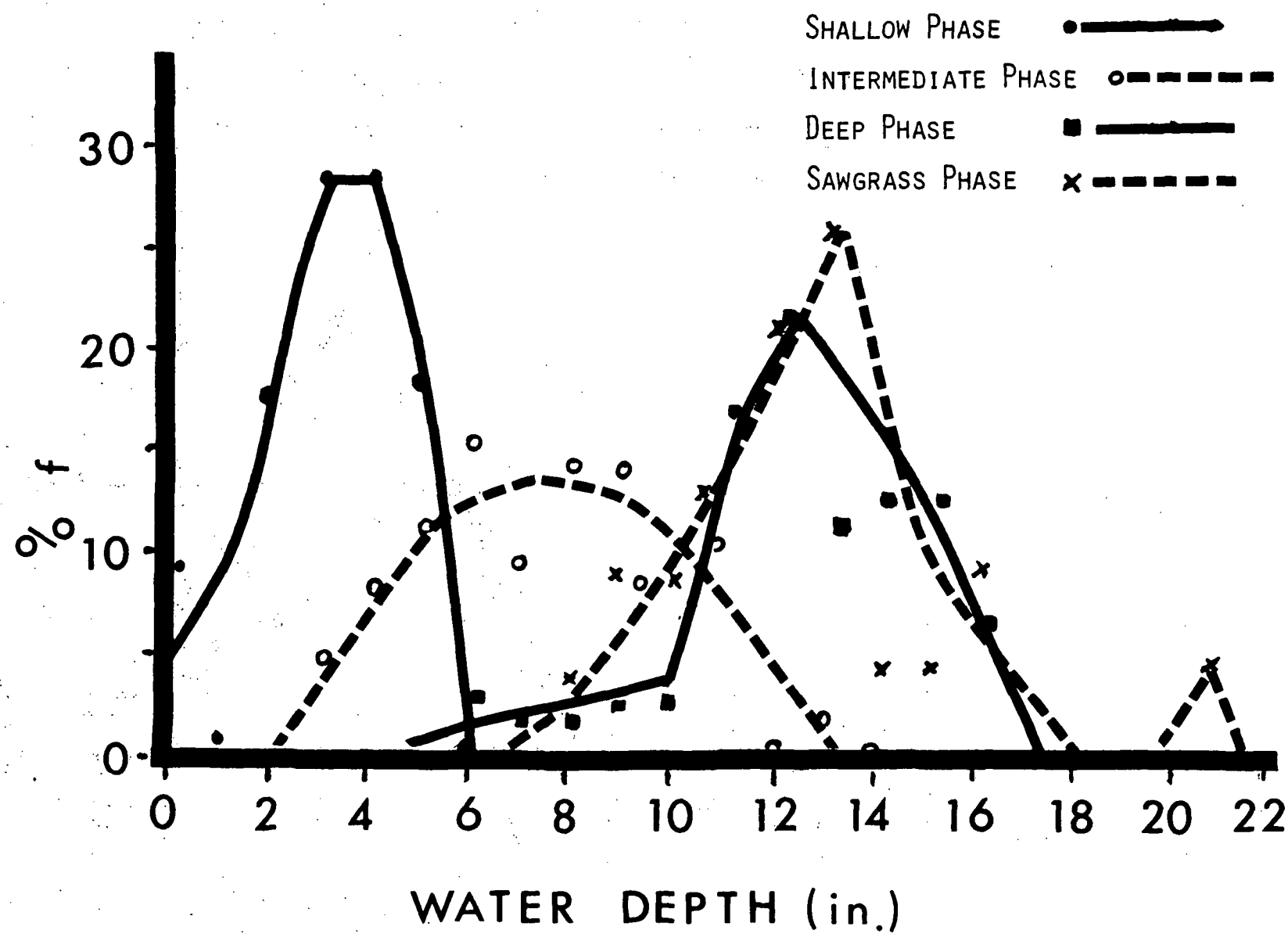


Figure 2

Figure 3 and 4. The Community Types of the South-Central Section of North Merritt Island Showing the Probable Area Paved (Black) and cleared (Brown) as part of the Shuttle Landing Facility.

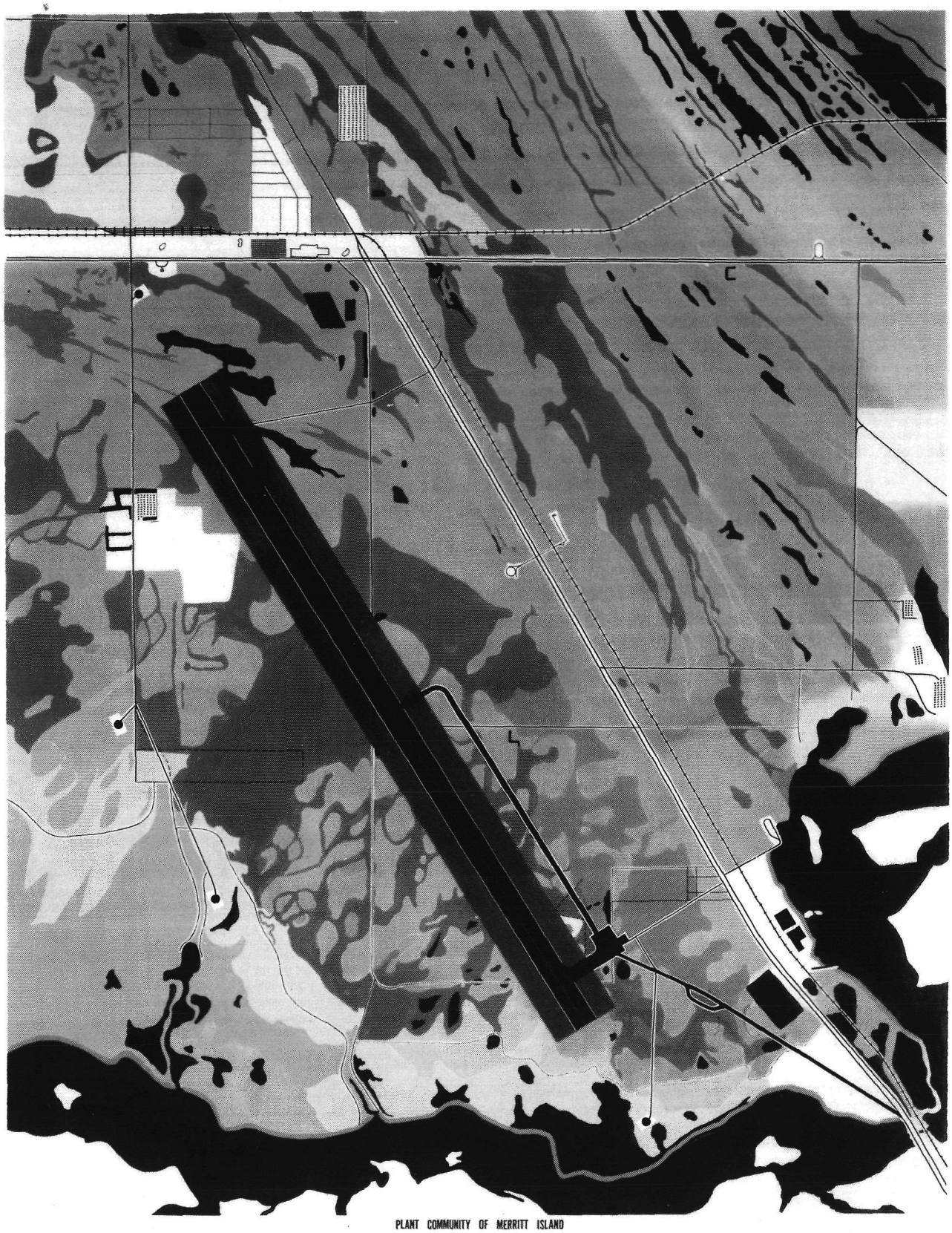


Figure 3 and 4

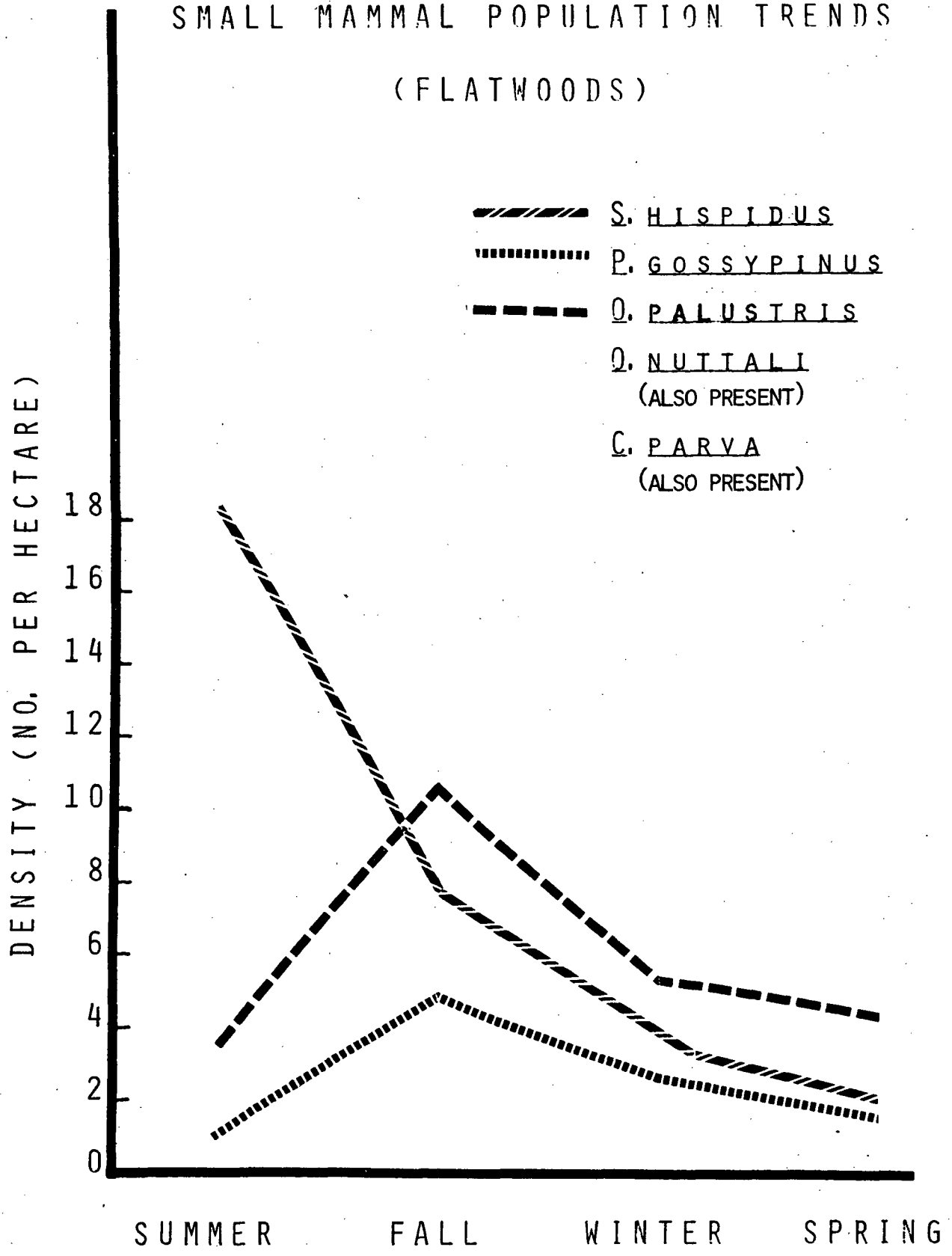

SMALL MAMMAL POPULATION TRENDS
(FLATWOODS)
S. HISPIDUS
P. GOSSYPINUS
O. PALUSTRIS
O. NUTTALI
(ALSO PRESENT)
C. PARVA
(ALSO PRESENT)
DENSITY (NO. PER HECTARE)
0
2
4
6
8
10
12
14
16
18
SUMMER
FALL
WINTER
SPRING

Figure 5

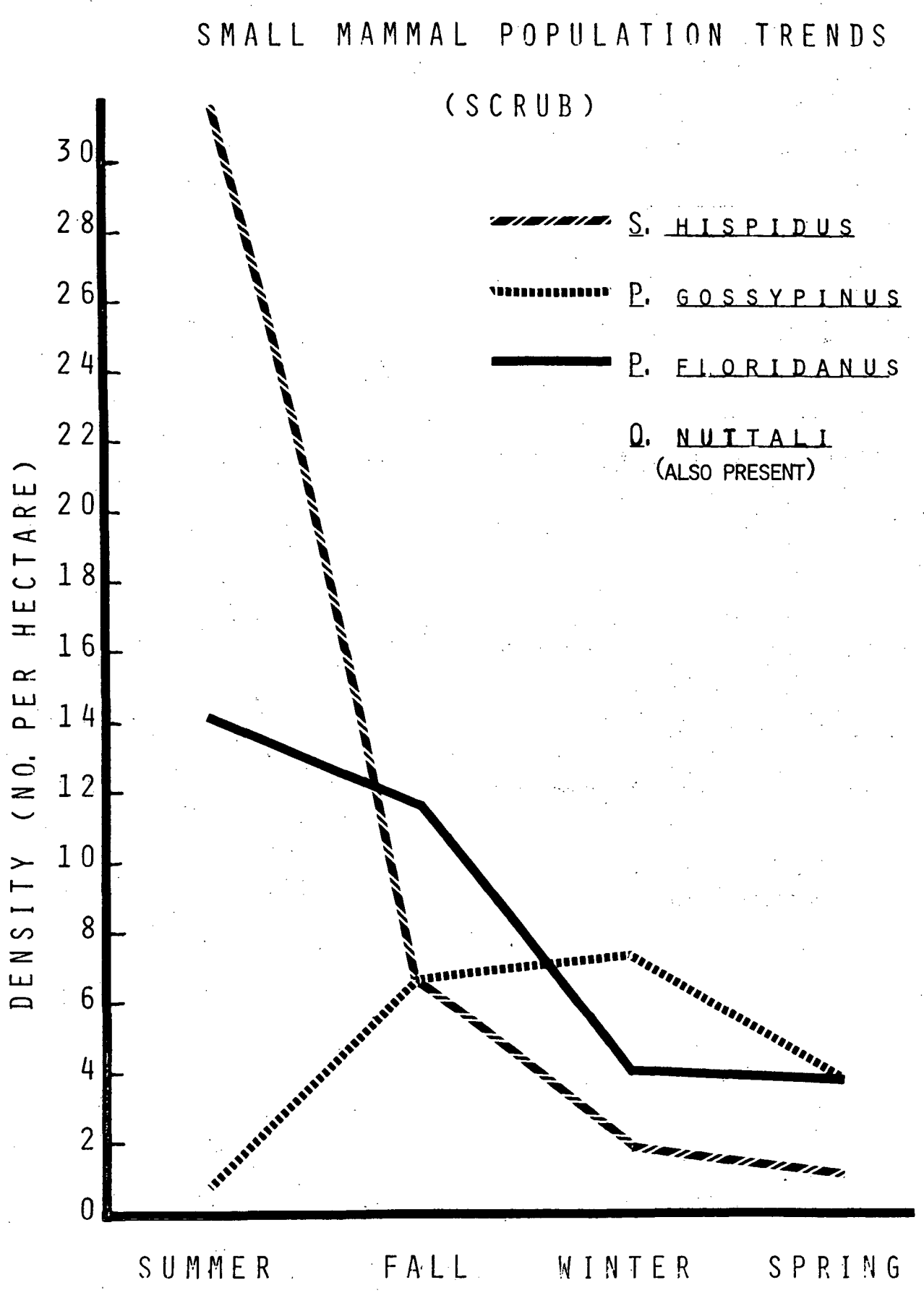

SMALL MAMMAL POPULATION TRENDS
(SCRUB)
S. HISPIDUS
P. GOSSYPINUS
P. FLORIDANUS
O. NUTTALI
(ALSO PRESENT)
DENSITY (NO. PER HECTARE)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
SUMMER
FALL
WINTER
SPRING

Figure 6

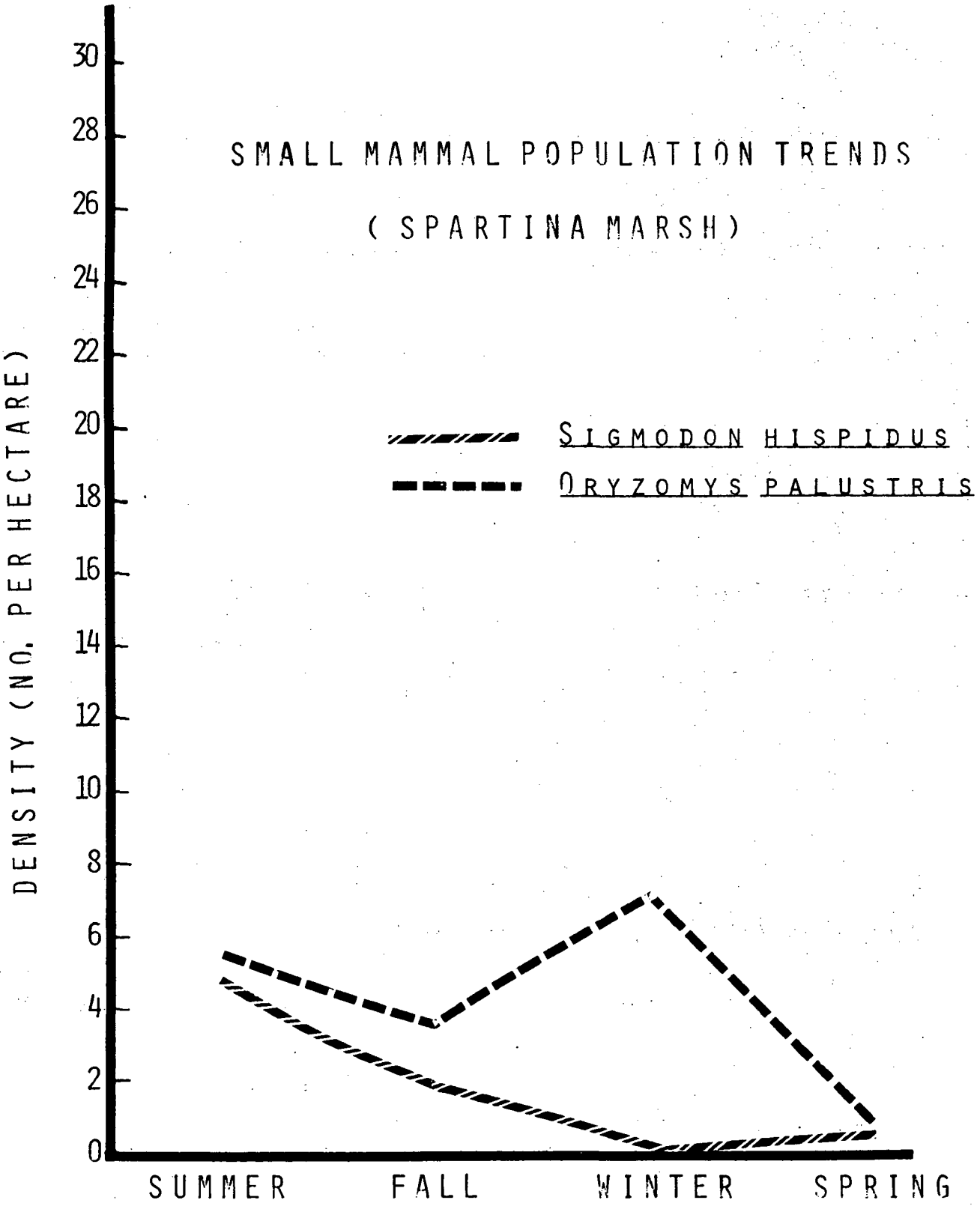

SMALL MAMMAL POPULATION TRENDS
(SPARTINA MARSH)
SIGMODON HISPIDUS
ORYZOMYS PALUSTRIS
DENSITY (NO. PER HECTARE)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
SUMMER
FALL
WINTER
SPRING

Figure 7

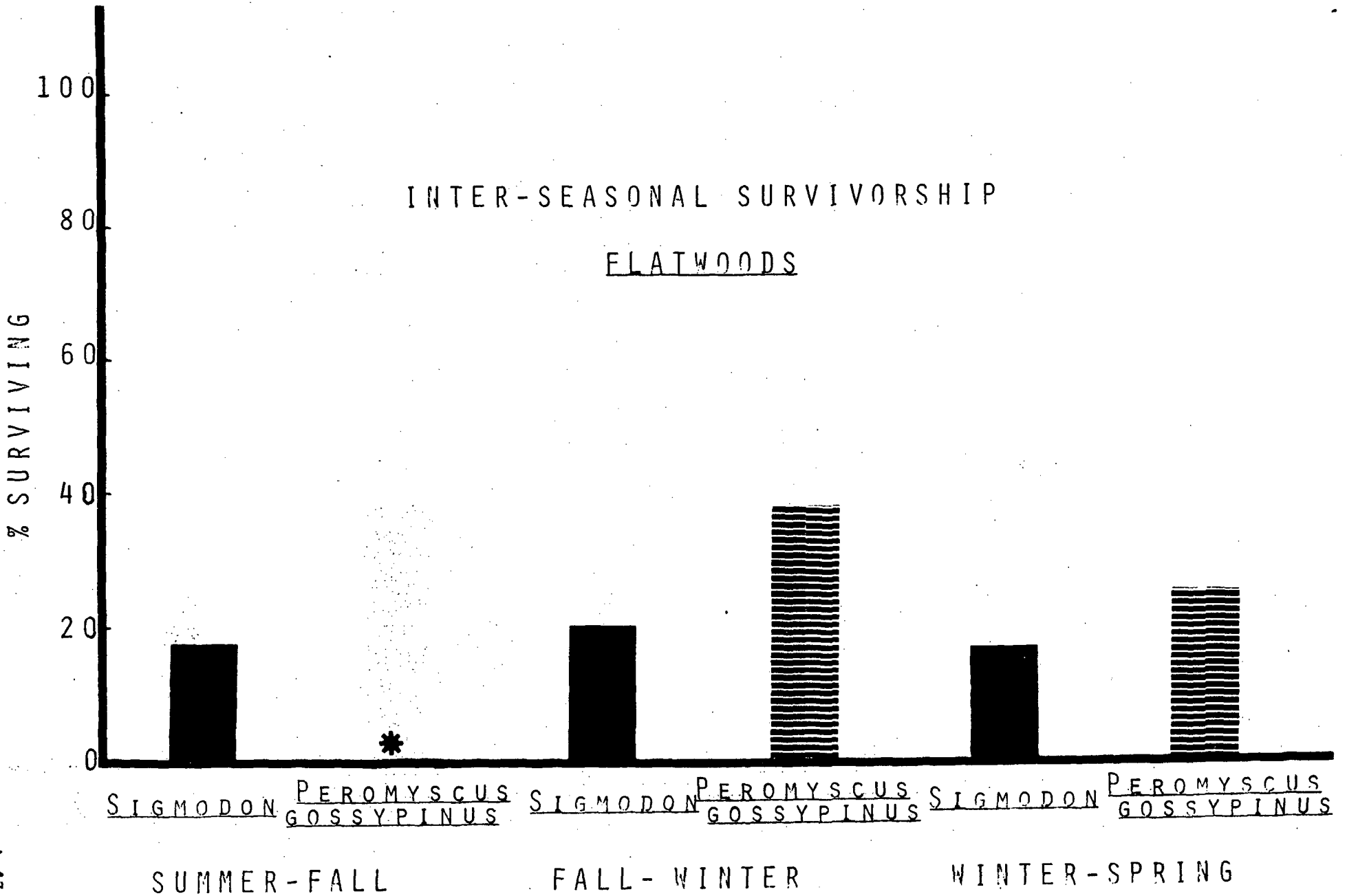

INTER-SEASONAL SURVIVORSHIP
FLATWOODS
% SURVIVING
100
80
60
40
20
0
SIGMODON
PEROMYSCUS GOSSYPINUS
SIGMODON
PEROMYSCUS GOSSYPINUS
SIGMODON
PEROMYSCUS GOSSYPINUS
SUMMER-FALL
FALL- WINTER
WINTER-SPRING

Figure 8

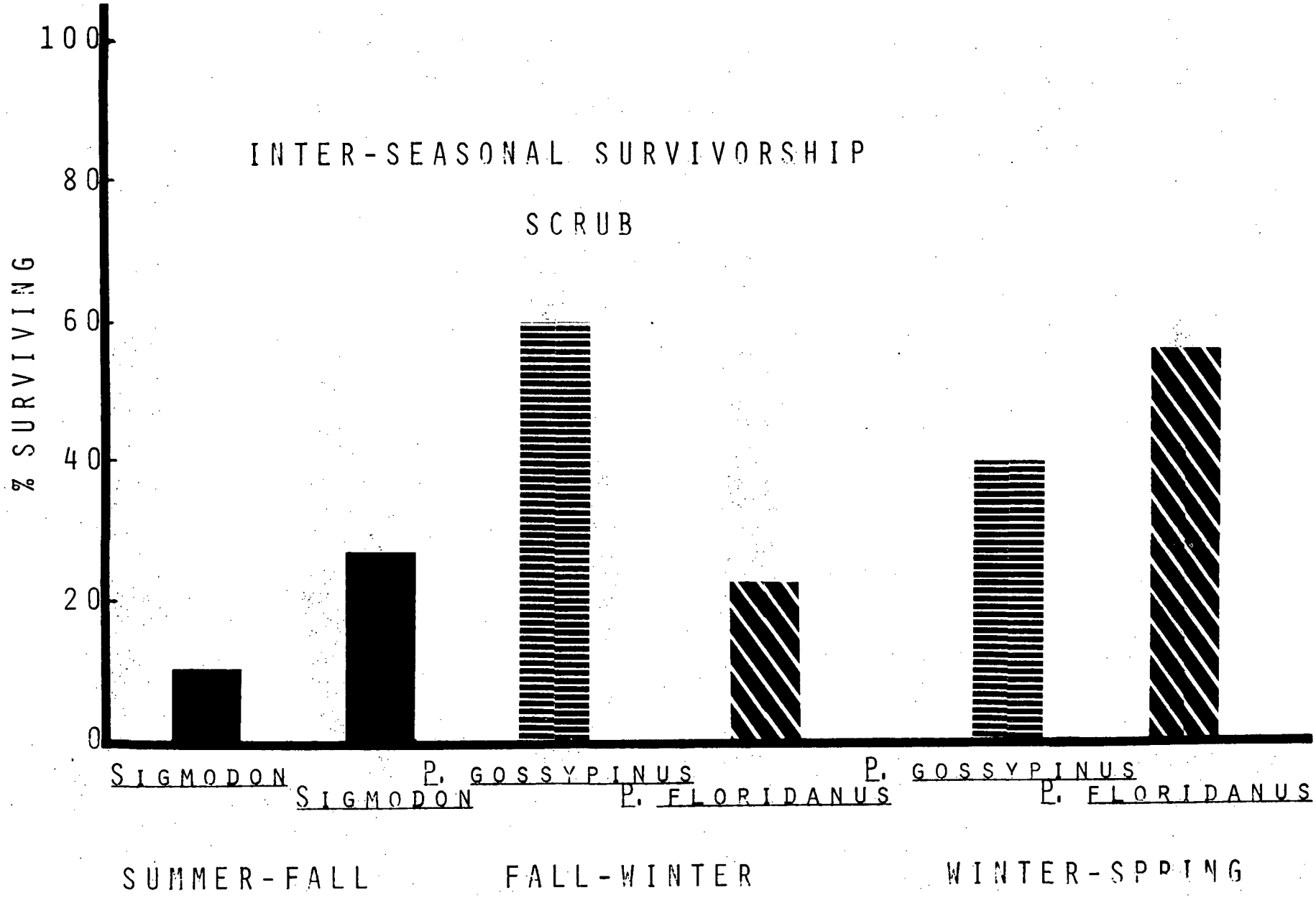

INTER-SEASONAL SURVIVORSHIP
SCRUB
% SURVIVING
100
80
60
40
20
0
SIGMODON
P. GOSSYPINUS
SIGMODON
P. FLORIDANUS
P. GOSSYPINUS
P. FLORIDANUS
SUMMER-FALL
FALL-WINTER
WINTER-SPRING

Figure 9

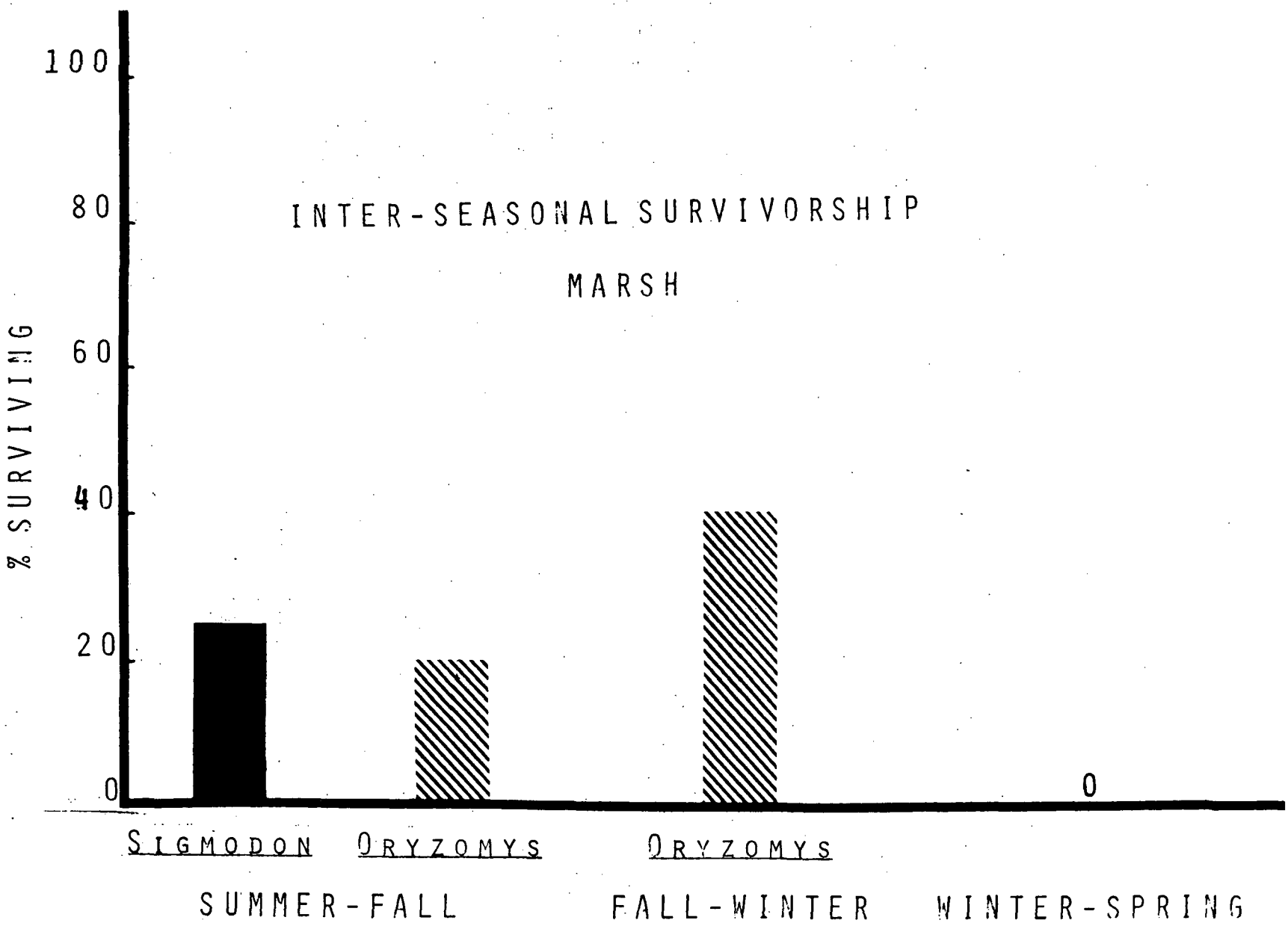

INTER-SEASONAL SURVIVORSHIP
MARSH
% SURVIVING
100
80
60
40
20
0
0
SIGMODON
ORYZOMYS
ORYZOMYS
SUMMER-FALL
FALL-WINTER
WINTER-SPRING

Figure 10

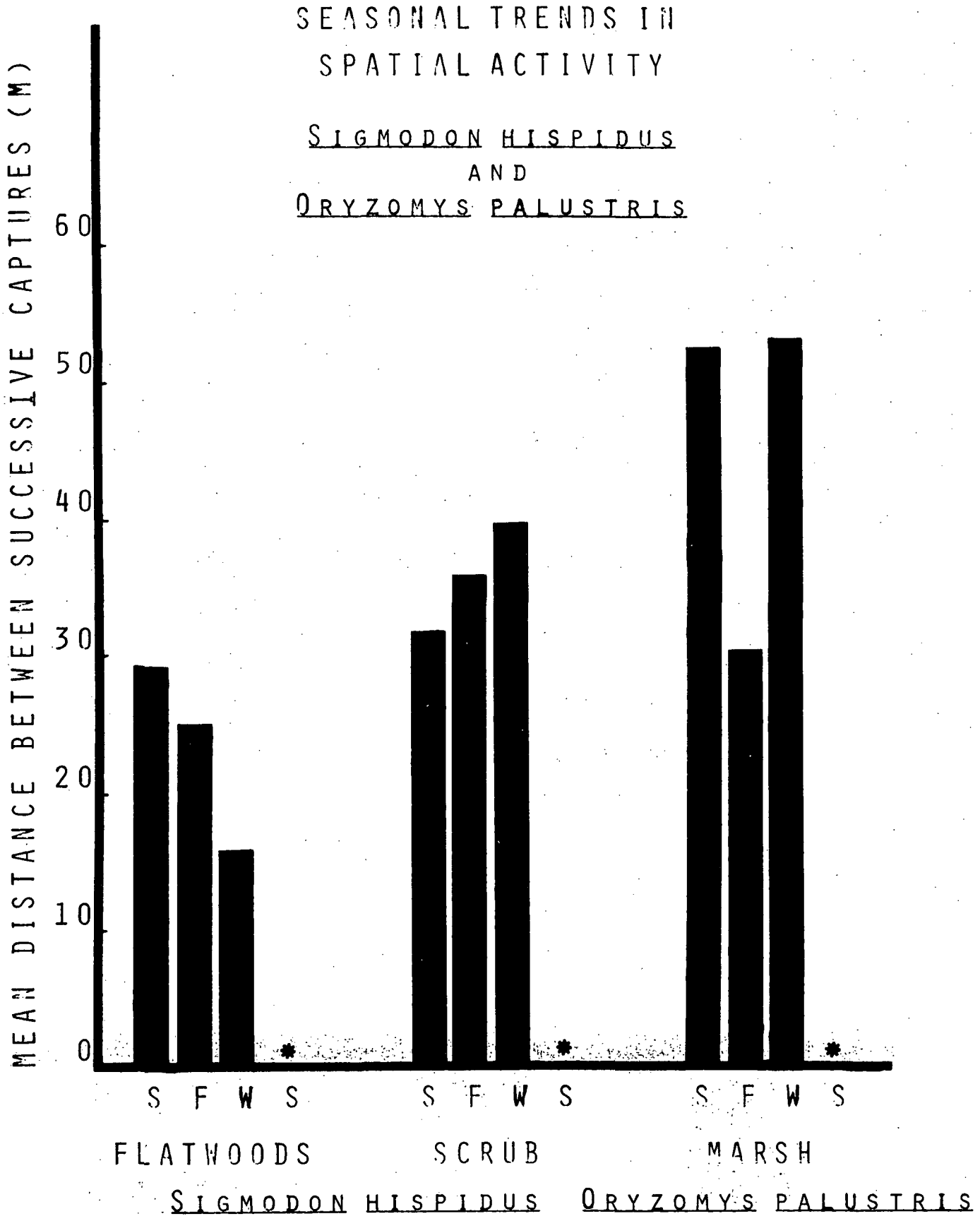

SEASONAL TRENDS IN
SPATIAL ACTIVITY
SIGMODON HISPIDUS
AND
ORYZOMYS PALUSTRIS
MEAN DISTANCE BETWEEN SUCCESSIVE CAPTURES (M)
0
10
20
30
40
50
60
S F W S
S F W S
S F W S
FLATWOODS
SCRUB
MARSH
SIGMODON HISPIDUS
ORYZOMYS PALUSTRIS

Figure 11

SEASONAL TRENDS IN SPATIAL ACTIVITY

Peromyscus gossypinus AND *Peromyscus floridanus*

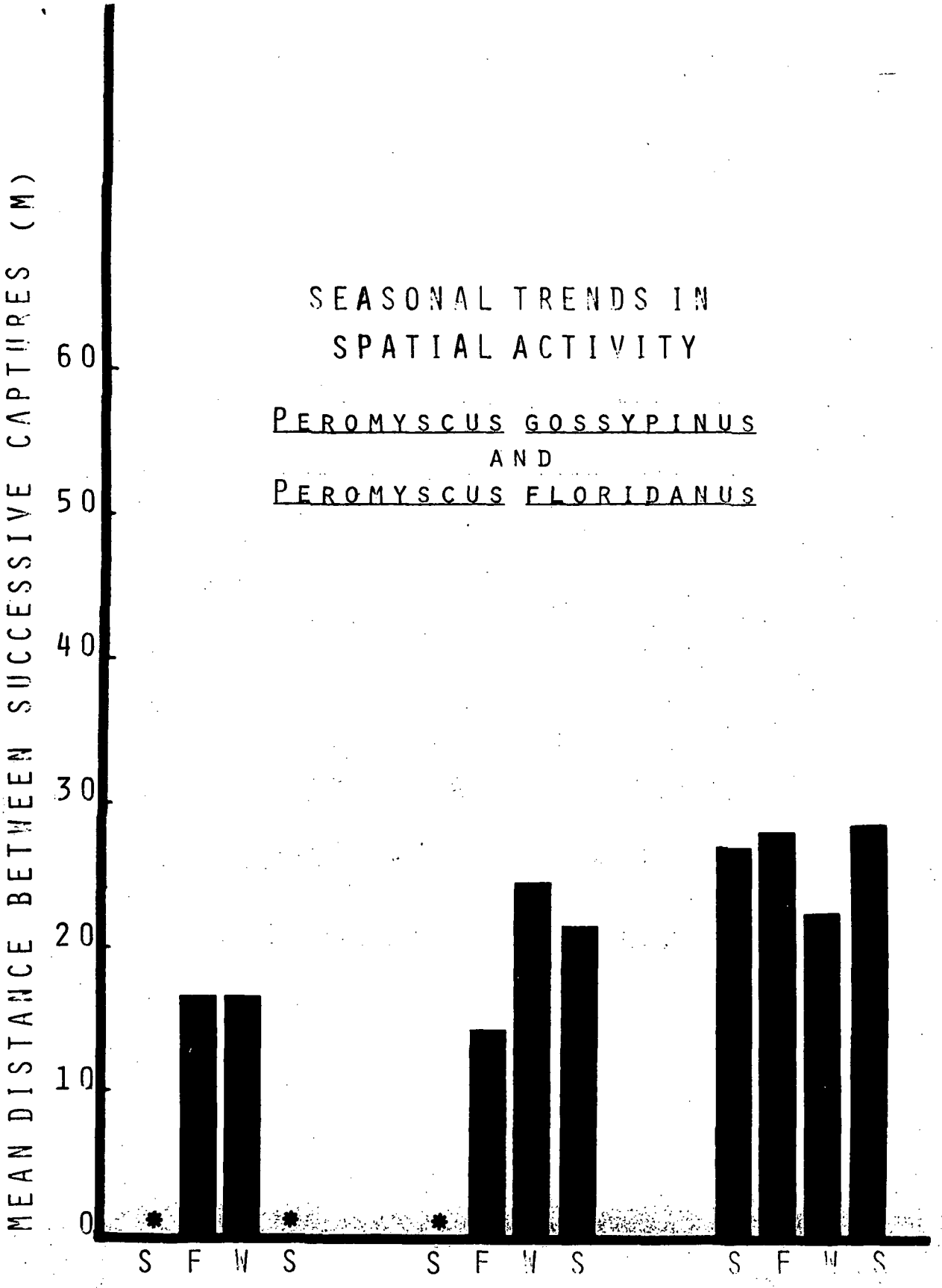


Figure 12

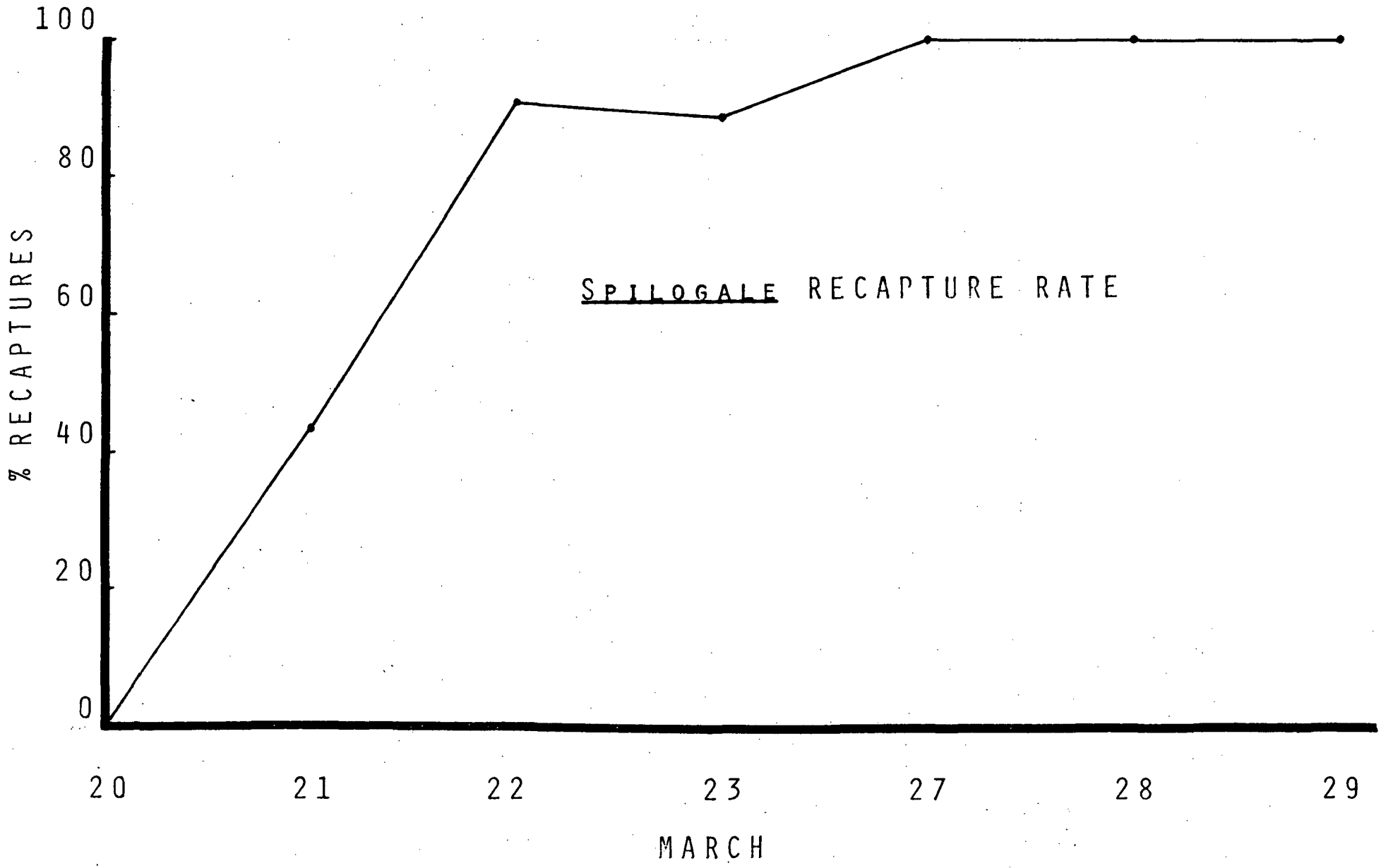

100
80
60
40
20
0
% RECAPTURES
SPILOGALE RECAPTURE RATE
20
21
22
23
27
28
29
MARCH

Figure 13

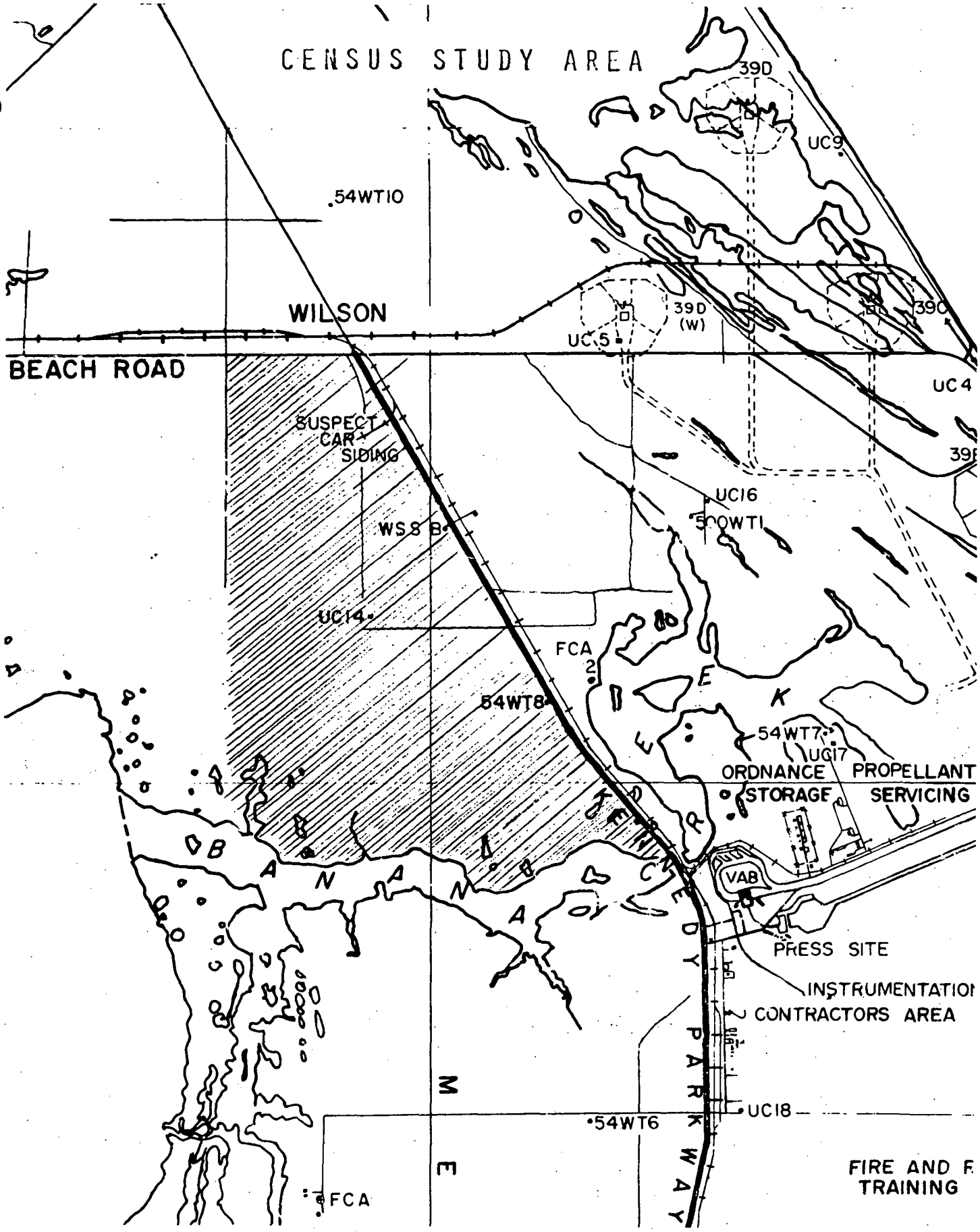

CENSUS STUDY AREA
39D
UC9
54WT10
WILSON
39D (W)
UC5
39C
BEACH ROAD
UC4
SUSPECT CAR SIDING
UC16
54WT9
WS 8 B
UC14
FCA 2
54WT8
54WT7
UC17
ORDNANCE STORAGE
PROPELLANT SERVICING
VAB
PRESS SITE
INSTRUMENTATION
CONTRACTORS AREA
UC18
54WT6
FIRE AND R
TRAINING
FCA
BANANA RIVER
KENNEDY PARKWAY

Figure 14

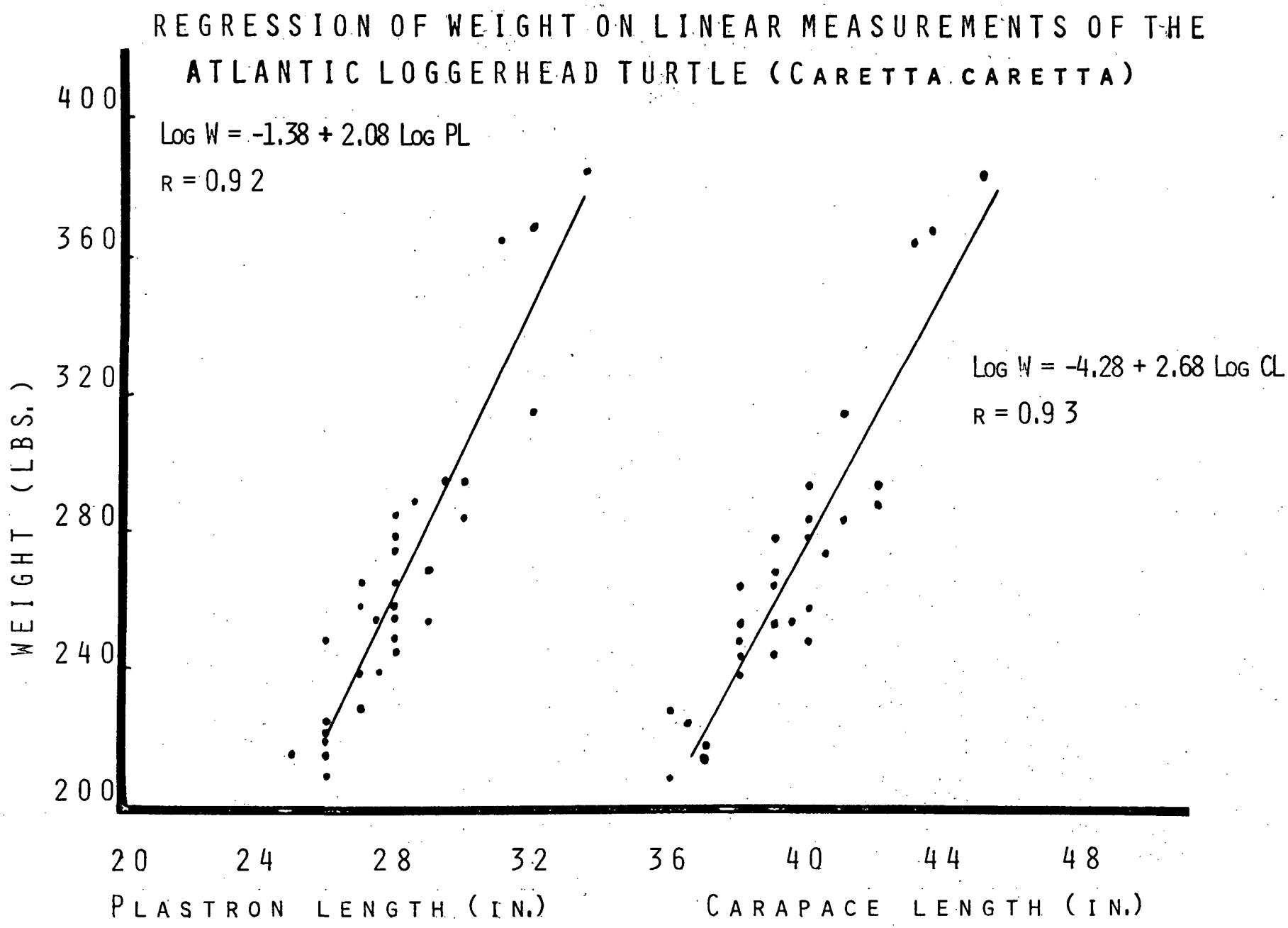

REGRESSION OF WEIGHT ON LINEAR MEASUREMENTS OF THE ATLANTIC LOGGERHEAD TURTLE (CARETTA CARETTA)
LOG W = -1.38 + 2.08 LOG PL
R = 0.92
LOG W = -4.28 + 2.68 LOG CL
R = 0.93
WEIGHT (LBS.)
400
360
320
280
240
200
20
24
28
32
36
40
44
48
PLASTRON LENGTH (IN.)
CARAPACE LENGTH (IN.)

Figure 15

PERCENT OCCURRENCE AND MEAN RELATIVE ABUNDANCE OF TEN FISH SPECIES AT VARYING SALINITIES

NOTE: Bars represent percent of collections in a given salinity range that contained the species; numbers at top of bars represent mean relative abundance (in fish per minute) in that salinity range.

SALINITY CLASS: 1. = 0 PPT. 2. = 1 - 5 PPT. 3. = 6 - 15 PPT. 4. ≥ 16 PPT.

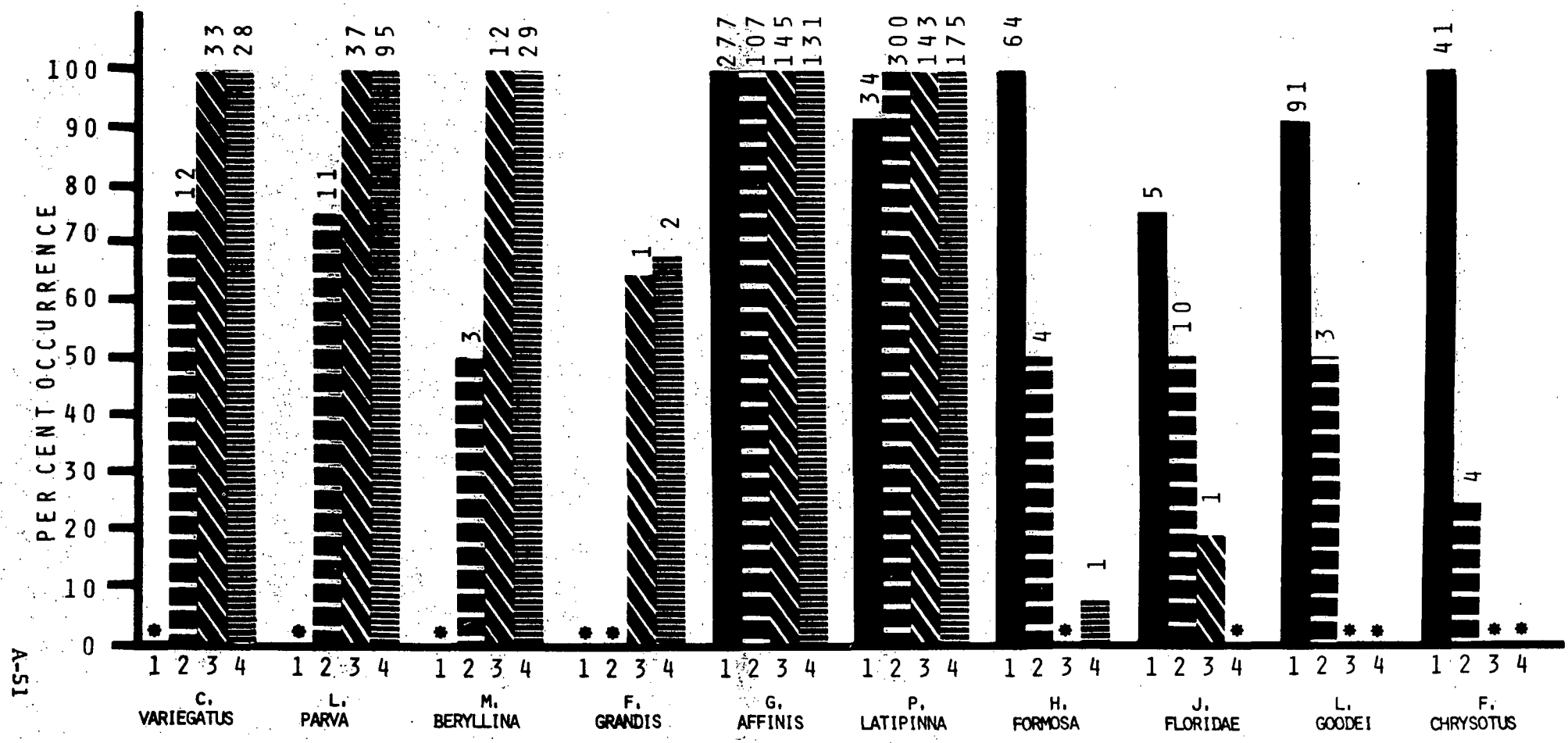


Figure 16

REGRESSION OF EMBRYO COUNTS ON TOTAL LENGTH IN THE VAB POPULATION OF POECILIA LATIPINNA.

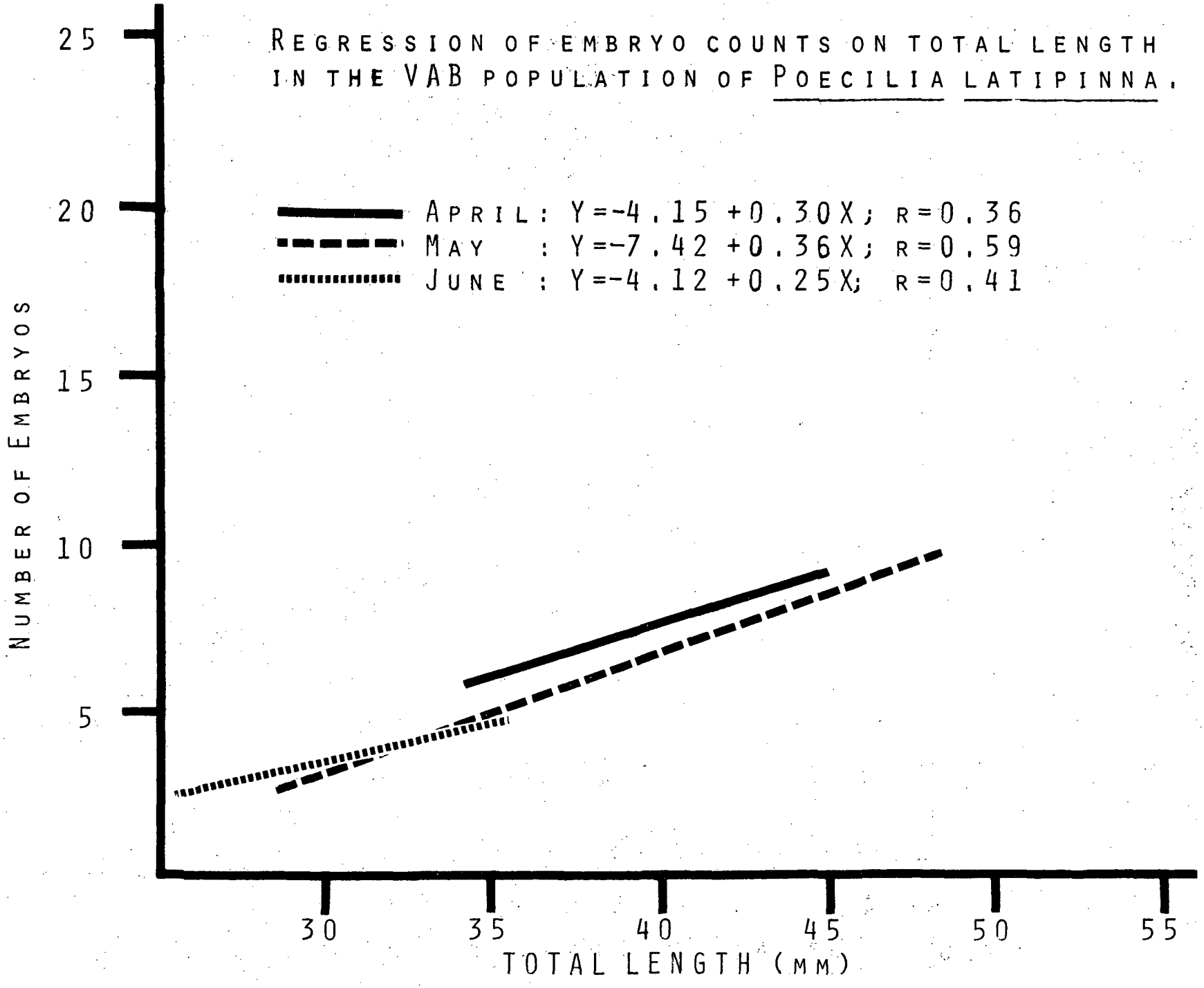


Figure 17